THE AEROPLANE

Incorporating
Aeronautical Engineering
Edited by - - THURSTAN JAMES

Founder and First Editor (1911-1939), C. G. GREY

Proprietors:
TEMPLE PRESS LIMITED
Chairman and Managing Director:
ROLAND E. DANGERFIELD

Head Office:
BOWLING GREEN LANE, LONDON, E.C.1.
Telephone: Terminus 3636
Telegrams:
"Pressimus London Telex"
Telex 23839

Vol. XCV. No. 2450 AUGUST 15, 1958

Annual Subscription Rate: U.K. £4.15.0. Overseas £5. Canada and U.S.A. $15.00

SEA-BORNE COMMUNICATIONS

IN a week expected by many to be that in which at least one attempt is made to send a rocket to the moon, it may not be so obvious that the most significant news to this island country has been the interruptions in the airlift between Cyprus and Amman. The Western Powers so established the ascendancy of the air by using the airlift to break the Soviet blockade around Berlin some years back that the very word "airlift" has come to have an almost magical implication.

Events have a way of overtaking technical developments. We have got so used to aeroplanes flying round the World either with the aid of civil airfields or by the aid of flight refuelling, if on military duties, that we tend to overlook the fact that the ability of a country to use its aircraft for the transport of troops and military supplies not only depends on having the aircraft of the necessary capacity and range, but also on obtaining and retaining the goodwill of the countries over whose territories the best route lies, unless one's own Air Force has established air supremacy along the whole route. To a people for many hundreds of years accustomed to the freedom of action conferred by the sea on a naval power, these limitations are difficult to apprehend. So long as one's ships keep out of territorial waters you can send them where you please, even under the Polar ice! But even if, like the "Nautilus," our long-range aircraft were nuclear-powered they would still be up against this question of national sovereignty over airspace.

This matter was discussed at some length in THE AEROPLANE for May 23 by two internationally famous figures. It is true that Sir Frederick Tymms and Sir William Hildred were approaching the subject from the aspect of it not being possible to have international acceptance of national sovereignty in space, nevertheless their article justifies further consideration at this stage. When the space ship has been evolved it will not be practical politics, some may argue, for any power to say that it will not permit military spacecraft to be flown over its territory. But this has not yet been evolved and an increasing number of people today are coming round to the point of view that the anti-missile missile is a practical, if very expensive in money and time, possibility. If the anti-missile missile becomes a feasible defence, then nations will be apt to continue jealously to guard that segment of the atmosphere, and beyond, which is outlined by radii from the Earth's centre passing through their national frontiers on the surface of the globe. Consideration of the practical delineation of such frontiers in space becomes a nightmare.

Let us return then to more earthbound considerations. For instance, the maintenance of links between the islands of the United Kingdom and the components of the Commonwealth and Empire has always exercised the minds of those able to look ahead. In the years between the Wars regular readers of THE AEROPLANE were always being reminded of the importance of having airfields on islands in the Indian Ocean in order to secure the airlinks between Australia and British territory in Africa. Unfortunately, so slow has been official action in this matter that the airfield at Gan in the Laccadive Islands has still to be put into commission. The need for such a link grows daily more important.

We have lost control of one end of the Red Sea; the other at Aden is threatened by the rising tide of Arab nationalism and the forthcoming independence of Somaliland. We still have friends in various Arab states around the Hadramaut and up the Persian Gulf. The fact that our airlift to Amman has been stopped by the Israeli Government makes one wonder whether aeroplanes of even the longest range are the proper answer. Could it be that the flying-boat is still, with its ability to dispense with airfields and the fact that it must largely fly over the surface of sea, an aid to Imperial communications that we have been foolish to discard?

What would have been the position at Akaba this past week if the Saro Princess flying-boats instead of being moth-balled and engineless had been in commission with the R.A.F.? Could they not have been flown from the Central African Lakes to the Red Sea?

At the moment the possibility of a British contribution to the launching of a space satellite is in the air. This is an idea that we have often expressed enthusiasm for, and no doubt it is only to be expected that this country will eventually do something to participate in the opening up of space travel. But the business of living is largely concerned with getting on fastest with the things that matter most. It could be that the re-introduction of the flying-boat plus a possible application of nuclear power to it might pay more immediate dividends in keeping the Commonwealth and its friends together than a prolonged expenditure of talent and treasure upon a British satellite. Anyway let us remember that the original performance figures for the Saro Princess flying-boats called for a range of 6,000 miles and a cruising speed of 350 m.p.h. So far as size is concerned there is plenty of room to carry impressive loads. Perhaps someone expert in flying-boat matters will tell us whether these big boats could have been used in the present emergency.

MATTERS OF MOMENT

British Satellites?

SPEAKING at Adelaide recently, Mr. Aubrey Jones, U.K. Minister of Supply, is reported to have said that the Royal Society was considering whether the huge expense of using big rockets to launch satellites would be warranted.

If it were decided to go ahead with a British satellite programme, it seems likely that the re-entry vehicle Black Knight would be the means of putting it into orbit. Black Knight is said to be under development by Saunders-Roe for investigations of the atmospheric re-entry of missiles.

Since Saunders-Roe now work in collaboration with de Havillands, Black Knight may be some relation to the de Havilland Propellers Blue Streak LRBM weapon. Thus the main components, including the Rolls-Royce-built Rocketdyne engine, would be common. It would presumably be possible to use a two-stage rocket for satellite launching.

Another means for putting a British satellite into orbit was described in our issue for February 14 when we reported on a paper given by Mr. J. E. Allen, B.Sc.(Eng.), A.F.R.Ae.S., A.M.I.Mech.E., F.B.I.S., head of aerodynamics in the projects and assessment department of the Avro Weapons Research Division. Mr. Allen suggested the use of an air-launched vehicle with four stages, suitable for launching from an Avro Vulcan flying at about 35,000 ft.

This vehicle—which bore a likeness to the Avro stand-off bomb—would attain Mach 15 and a height of 1,000 miles with a 300-lb. payload. In this context it is interesting that an Australian report refers to a Vickers Valiant now being used at Woomera to test the stand-off bomb, which is said to attain supersonic speed and to have a range of 400 miles at heights up to 60,000 ft.

From another source it has been learnt that, while the bomb is carried externally by the Avro Vulcan, the Handley Page Victor has sufficient internal capacity for its stowage.

Anti-missile Investigations

IN noting that the Minister of Supply, Mr. Aubrey Jones, is reported to have revealed the existence of work on a British Anti-Inter-Continental Ballistic Missile (AICBM), it is apposite to recall that nearly two years ago we printed an article which examined the then almost heretical idea of devising counter measures for the Inter-Continental Ballistic Missile.*

As with other "ultimate" and "fiendish" weapons from the cross-bow to the first atomic bomb, there had allegedly been no defence against the ICBM and only the "deterrent" of a bomber force was considered to be of any use.

Clearly, however, a deterrent is only of use so long as it deters, and if ICBMs *should* be launched against our country—the attacking nation being confident of taking care of any attempt at retaliation by V-bombers—there would be immediate need for some form of positive, rather than abstract, defence.

There is no doubt that the problem has been worked on for some time here and in the United States. Our friends in America have already planned the Nike-Zeus AICBM which should be in operational service within four years, and this form of defence may well cost them as much as $2,000 million a year from now on—a fact which has caused due consternation in Congress. It is estimated that it will be at least two years before the Ballistic Missile Early Warning System (BMEWS) radar set-up is in operation. This system will have four detection and three tracking radar sets each at Thule, Greenland and Fairbanks, Alaska. A third site may also be selected later.

In the past nine years North American Air Defence (NORAD) has spent $18 million for defensive radar and other equipment, but will be required to be maintained at least at this level for a decade or more before guided weapons have entirely replaced manned military aircraft.

These figures give some idea of the tremendous cost of defence against the ICBM and the order of investment required for a British AICBM, bearing in mind the relative size of the areas to be defended.

There is no clue yet about the prime contractor for our AICBM. It would be unfair to hazard a guess at the probable identity of the aircraft manufacturer concerned although it might be surmised that the most successful company in the guided-weapons field should get the job.

It would also seem logical that a company experienced in infra-red guidance would be the choice because kinetic heating of the missile nose-cone on re-entering the atmosphere provides a fruitful source for detection. Indeed, on recent tests of the U.S. Army Jupiter IRBM the nose-cone proved to be an even better radiator of infra-red than was expected.

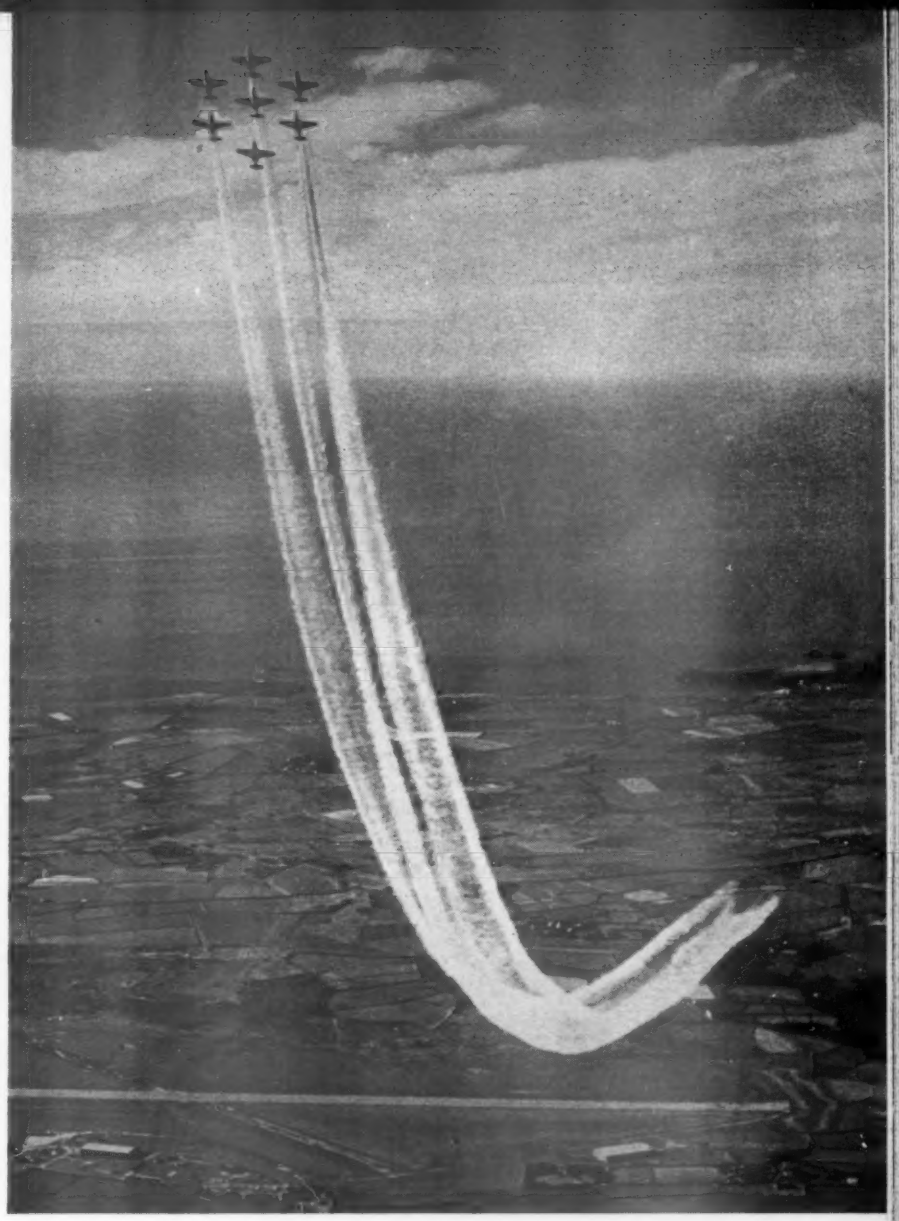
On a recent visit to R.R.E. Malvern (THE AEROPLANE, May 2) details were given of a new type of infra-red detector cell using indium-antimonide. The results of this work may well now be directed at use in the AICBM although, as we said at the time, an AICBM would be likely to use more than one guidance system because of the great range at which it must intercept its quarry.

An alternative system to infra-red guidance is that used for the Nike-Zeus. This uses electro-magnetic disturbances caused by the ICBM re-entering the atmosphere and accelerating towards the target area. The complete Nike-Zeus system includes electro-acoustic early warning detection, tactical control and missile tracking radar, the missile's own homing radar, and the rocket-powered missile itself.

Whichever system the British AICBM uses, it has been said that a "90% operationally effective" weapon of this type could be developed within three years. Presumably, such very speedy development could only be possible on very high priority ratings—if then.

* "Defence Against the ICBM," by Dr. I. J. Billington, A. L. Cole and B. S. Lamb, of the Canadian Westinghouse Company, THE AEROPLANE, October 26 and November 2, 1956.

NEW STRIKER.—A new picture of the Blackburn and General Aircraft NA.39 (two D.H. Gyron Junior turbojets), development flying of which is proceeding.



FARNBOROUGH REHEARSAL.—Sea Hawks of No. 800 Squadron, R.N., led by the C.O., Lieut. Cdr. N. P. Perrett, R.N., are seen here in "double-vic" formation near R.N.A.S. Brawdy. The squadron is to perform at the S.B.A.C. Display at Farnborough.

Photograph copyright "The Aeroplane"

Lee-on-Solent's Air Day

WHEN the Navy put on an Air Day they organize it pretty thoroughly, but not even matelots can do much about an English summer. At R.N.A.S. Lee-on-Solent on Saturday, August 9, a low ceiling and thick weather washed out half the scheduled programme. Very properly, the all-weather fighters, Scimitar and Sea Vixen, were undaunted and, bringing their own shimmy clouds with them, roared in and out of the cloud base. Then No. 781 Sqn., also noted for their all-weather flying, made a genteel pass with a formation of their Devons; a Vulcan demonstrated its impressive speed range, followed by a total contrast in size and noise from Norman Jones' Turbulent.

The rest was nearly all helicopters. Fabulous and frightening were Lieut. Cdr. Ted Spreadbury's "Hillerbatics"; the Fairey Ultra Light popped up from its lorry with striking vertical acceleration; an S-51 carried beneath it a magic carpet with a flute-playing "snake-charmer," a Whirlwind rescued a ditched pilot from a grassy grave, another carried a car around; 13 assorted helicopters played follow-my-leader; another Whirlwind towed a glider; and 12 paratroops jumped from four more Whirlwinds. From an Auster descended two more parachutists, one of them alighting just outside the airfield in the only glass-house for miles around.

There were hangars full of static and entertainingly dynamic displays of Naval equipment and aircraft industry exhibits.

—WREN.

Percival Finances

SOME weeks ago we reported the proposed winding up of Edgar Percival Aircraft, Ltd., of Stapleford Tawney; the first meeting of the company's creditors was held on August 6.

The assistant official receiver reported that the total deficiency with regard to creditors and shareholders was estimated at £318,975, and a draft statement of affairs revealed unsecured liabilities of £394,767. Assets were estimated at £104,578. Of the unsecured liabilities £344,326 was due to the Finance Corporation of Industry, Ltd., which had presented the petition for winding up the company, and there were additional preferential debts of £3,786.

Edgar Percival Aircraft, which was formed in November, 1954, with an issued capital of £25,000, has been engaged in the manufacture of the EP.9 agricultural aircraft. Capt. Edgar W. Percival, Mr. D. Ross and Mr. E. Barnsley were the directors.

The assistant official receiver said that the directors had given reasons for the company's failure, but he did not propose to go into the matter. It would appear that lack of orders for the EP.9 is not without relevance.

So far as we can ascertain, no developments have yet followed the proposed purchase of the company by Samlesbury Engineering, Ltd.

Contents of this Issue

MATTERS OF MOMENT .....214 and 232
NEWS ITEMS 217
AIR TRANSPORT 219
CARIBOU CONSTRUCTION (pictures) 221
THE FIGHTING SERVICES 222
LUNAR PROBE, by James Strong 223
INTRODUCING THE GNOME 225
IMPRESSIONS OF THE STRUCTURAL DESIGN OF AMERICAN CIVIL AIRCRAFT—Part 1, by A. F. Newell 229
FAIREY'S AIR-TO-AIR BEAM RIDER 233
PRIVATE FLYING 237
SAILPLANES AT LESZNO, 1958—Part 2, by Peter Brooks 238
NATIONAL GLIDING WEEK—Report by Dr. A. E. Slater 240
CORRESPONDENCE 241
WREN'S WROUNDABOUT 241
NOTES AND EVENTS 242
PERSONAL NOTICES 242

Showing Them How

TOWARDS the end of their four-week visit to the United Kingdom, eight of 10 air cadets from overseas (two each from France, Holland, Italy, Sweden and Turkey) went to Croydon Airport on August 10 to see a British flying club in operation. Acting as host was the Surrey Flying Club, whose C.F.I., Mr. Peter Chinn, along with several members, entertained them to lunch and showed them around the historic airport. A picture is on page 218.

In charge of the party was Flg. Off. B. Butterworth, of R.A.F. Home Command, which had arranged the visit in conjunction with the Association of British Aero Clubs and Centres.

John Fricker's Report

Parachuting Championships

RUSSIA won all four of the main events in the International Parachuting Contests at Bratislava, Czechoslovakia. The new world men's champion is Piotr Ostrowski, and the women's champion is Miss Priachinova. The team events, men and women, were also won by Russia.

Competitive parachuting is now a highly advanced international sport. Teams from Austria, Britain, Bulgaria, Canada, Czechoslovakia, France, Hungary, Israel, Poland, Rumania, Russia, the U.S.A. and Yugoslavia, all went to the grass airfield of Vajnory, just outside Bratislava, in the South-east of Czechoslovakia, for the World Championships, which began in light winds and fair weather on August 4, after a most discouraging opening the day before.

Inevitably, the small British team of Mike Reilly (captain), J. McLoughlin, D. Lee and Sue Burges (who competed in the women's section), assisted by Major "Dumbo" Willans as delegation leader and the writer as pilot, were up against some extremely formidable opposition. Apart from the highly organized and almost professional teams from the Eastern European countries (the Russian contingent in Bratislava comprised some 35 members and two aircraft), this year there was additional competition from a very well-trained and equipped American team.

Since their first appearance in the World Parachuting Championships in Moscow, two years ago, the Americans, led by Jacques Istel, have worked up to an extremely high standard of competition parachuting. For the current contest, several of them completed a course at the French parachute school at St. Yan before returning to the U.S. to impart their knowledge to other members of the team, which is fabulously equipped.

The French, for their part, are still perhaps the leading exponents of body control in free fall, known popularly, if inaccurately, as sky-diving, but are considerably handicapped by having parachutes which have limited steering capabilities.

Since a British team first introduced them at the St. Yan contest, four years ago, so-called "blank-gore" parachutes, which have one complete section removed between apex and periphery of the canopy, have become almost universally adopted for sporting parachuting. The airflow through the open gore gives the parachute during its descent a forward speed of about 4 m.p.h. or more through "jet" effect. By pulling one or the other of the adjacent rigging lines, the gore can be deflected to give a rapid turning effect. A high degree of controllability in skilful hands results.

With the exception of the French and one or two of the other contestants, all the competing countries at Bratislava used blank-gore parachutes which have shown considerable advantages over the full canopies. McLoughlin and Lee of the British team also had to use the older-type conventional parachute which, as in the case of the blank-gore canopies of Sue Burges and Mike Reilly, were bought personally. The entire British effort has been without any financial assistance whatsoever.

Upper left, new World champion Piotr Ostrowski (Russia) shakes hands with Sue Burges (Britain). Right, Ala Skopinova (Russia) with blank-gore parachute winning the precision event from 1,000 m. Lower left, a Czech An-2 as used for the jumping.

Selection of the Czech team—the previous Champions—began as far back as May. Several weeks ago, two Antonov An-2 biplanes of the type to be used in the competition, and which are widely used in Eastern Europe for parachuting, were supplied to the Czechs by Russia for practice jumps. Four more were provided by the U.S.S.R. for use by all contestants during the actual competition. The Hungarian team brought its own An-2 to Bratislava.

Monday dawned overcast, but the weather rapidly improved and jumping started at the un-Marxly hour of 8 a.m. The original programme called for one jump per day by each of the 80 contestants until the scheduled eight were completed, but the Czech Aero Club appeared to want to take the maximum advantage of good weather, and two per day were completed in the initial stages of the contest.

Lots were drawn for the order of jumping of each team, and it fell to the Americans to lead off for the first event. This was a spot landing from 1,000 m. with immediate opening. A dummy was first dropped from an An-2 to give an indication of drift, after which the American captain, Jacques Istel, made a magnificent descent, landing only 5.6 m. from the centre of the 300 m. diameter target circle.

In addition to blank gores, the American Pioneer parachutes incorporate "slip risers," or lift-webs which may be unlocked after deployment. The complete canopy may thus be tilted for additional horizontal impetus.

The other Americans did quite well, all landing well within the circle. A girl in the French team, who followed, was the first of several contestants (including, alas, two of the British) to land outside, thereby scoring no points. One of the French, however, landed 4 m. from the centre, and a Bulgarian, Sarkov, landed a mere 21 cm. away. In the second jump of the first event, Gustav Koubek, last year's World Champion, from Czechoslovakia, achieved a distance of 1.78 m.

By the end of the day, Vodenicarov of Bulgaria had taken the lead, among the men, with two jumps of 6.93 and 1.97 m., closely followed by Gyulai of Hungary (5.64 and 5.33 m.), and Dmitrov of Russia (4.94 and 10.09 m.). The first American, Istel, was 19th (5.66 and 26.29 m.), but Mike Reilly, first among the British team, was back at 43rd position.

In the women's individual results on the first day, Ala Skopinova of the U.S.S.R. was only one point behind the top man, with jumps of 7.87 and 1.67 m., while second and third were girls from Rumania and Russia. Sue Burges (or Burgesova as she was listed) did well to come 18th, scoring more points than considerably more experienced women parachutists.

So far as team position was concerned Hungary was in the lead among the men after the first two descents, with Bulgaria, the U.S.S.R. and Poland lying second, third and fourth, while the order for the women was U.S.S.R., Bulgaria, Poland and Rumania.

On Tuesday, August 5, the third and most exacting event was held, out of sequence, because of very favourable weather conditions. The task was a jump from 2,500 m. (8,250 ft.), with a delay of between 35-43 sec., during which turns in free fall had to be performed. Their sequence was governed by a sign displayed on the ground between the 10th and 15th seconds of free fall, and the contestants had the remaining period of time to complete them.

With no cloud to interfere with visibility, and a light wind, conditions were ideal. Once again, the two jumps in this event were completed in one day. The dropping time was considerably extended by the half-hour or more taken by the An-2 to reach 8,000 ft., and the impossibility of having more than two aircraft at a time in the circuit because of identification problems.

Results for the Third Event put Russia strongly in the lead in both the team and individual men's championships. Four of the first five men were Russian, with Ostrowski in the lead, and Jehlicka of Czechoslovakia lying third. Koubek, current Champion, was well up in seventh position and Istel was 13th, but Reilly, top British man, was back at 51st.

News of Aircraft, Engines and Missiles

LIGHTWEIGHT.—A Fairey Ultra Light helicopter (Blackburn - Turboméca Palouste 500 air generator) is now flying in Royal Navy markings, plus civil registration. It will appear like this at Farnborough.

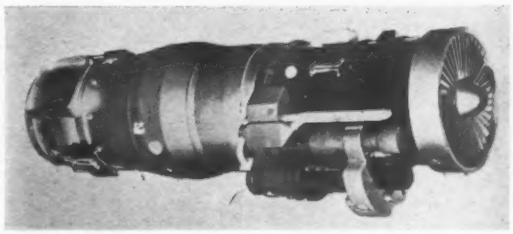
NEXT WEEK

THE issue of THE AEROPLANE dated August 22 will be a special number featuring "Canada's Aircraft Industry." The industry will be surveyed, along with descriptions of the leading aircraft types; a directory of the ancillary industry will be included, and there will also be features on Service and civil aviation in Canada.

This issue will cost the usual 1s. 6d.

P.1 NAMED.—The English Electric P.1 fighter (two Rolls-Royce Avon turbojets) has been named the Lightning. To many people this name is still associated with Lockheed's P-38 fighter of the Second World War, and this seems unfortunate. It should not have been difficult to have selected a completely distinctive appellation for the R.A.F.'s last manned fighter.

SUPER-BLOODHOUND. — Ferranti, Ltd., has announced that it is developing the Bristol/Ferranti Bloodhound ground-to-air missile to have a greater range for anti-aircraft and anti-missile defence. The first reference to further developments of this sort was given in the White Paper, "Britain's Contribution to Peace and Security," of February, 1958.



NEW BY-PASS.—Left, this is an early model of the Rolls-Royce RB.141 by-pass turbojet. Later versions of this 12,000-lb. thrust engine, which will probably look rather different, are destined for the D.H.121.

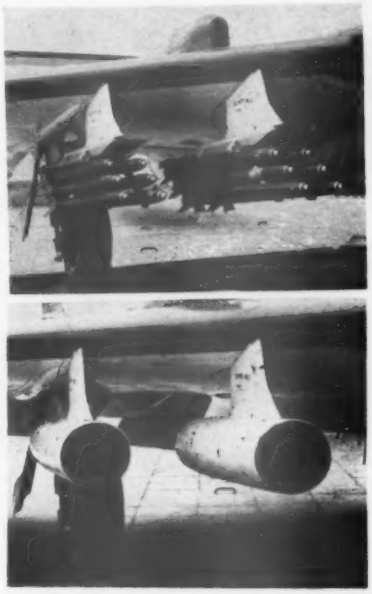
ELAND APPROVAL.—Type Certificate No. 305 has been awarded to the Napier Eland by the C.A.A. in the United States. Approval is for a take-off rating of 3,230 s.h.p., a thrust of 700 lb. and 3,500 e.h.p. at 12,500 r.p.m. The Eland was granted normal-category approval by the A.R.B. earlier this year.

SECOND TURBI.—The Druine Turbi, G-AOTK (Walter Mikron engine), built by the T.K. Flying Group made its first flight at Hatfield on August 9. It was flown by Mr. Pat Fillingham for ½-hr. and then by Mr. Neil Harrison, the group's treasurer. The first British-built Turbi, G-APFA, is at present at Elstree and now has a Continental engine in place of the Coventry Victor.

SCHOOL CLOSING.—The School of Gas Turbine Technology, which is operated at Farnborough by Power Jets (Research and Development), Ltd., will close on December 12 because the demand for instruction in gas-turbine technology has decreased. Six more courses on aero and industrial gas turbines will be held between August 18 and December 12. The Power Jets consultancy department, which has provided most of the School's lecturers, will remain in being to design and give advice on the design, manufacture and development of gas turbines, rotary compressors and related equipment.

DC-8 PROGRESS.—By August 4 the first production or prototype Douglas DC-8 had completed 45 hours in the air, flown mainly from Edwards Air Force Base. In all 13 flights were completed in the time and it has already been taken off at a gross weight of 255,000 lb.

BRISTOL RESEARCH.—According to reports, Bristol Aircraft, Ltd., is working on an "all-steel" research aeroplane for flight at very high speeds. Suitable powerplant would be two of the new D.H. Gyron Junior D.G.J.10 supersonic turbojets, possibly at the wing tips.



VIXEN ARMAMENT.—In the upper picture the D.H. Sea Vixen is carrying 24 3-in. ground-attack rockets, six to a pylon. The lower picture shows underwing 2-in. rocket packs, by Microcell, Ltd., with nose-caps off.

Commercial Aviation Affairs

COMET TO IDLEWILD.—The first production Comet 4, G-APDA, flew from Hatfield to New York International on August 10, via Gander, in a flying time of 9 hr. 5 min. The visit is primarily intended to allow the P.N.Y.A. to make noise-level tests on the Comet 4 under local conditions. The Comet 3 was tested at Hatfield last year and received a favourable report.

CENTRAL AFRICAN LOSS.—A Viscount 748 of Central African Airways crashed while approaching to land at Benina Airport, Benghazi, Libya, in the early hours of August 9. It was operating on the Zambesi coach-class service from Salisbury to London. Of the 54 persons on board, 37 were killed, including four of the crew, and most of the survivors received serious injuries.

EL AL GROWTH.—During the first six months of this year, during which their Britannia 313s have been in operation, El Al's passenger traffic increased to nearly 32,000 from about 19,000 for the same period of 1957. For the month of June the respective figures were 7,850 and 4,250. North Atlantic non-stop regularity and other El Al results were discussed in THE AEROPLANE of August 1.

ROYAL VIKINGS. — The three Vikings of The Queen's Flight have been taken over by Tradair, Ltd., of Southend, and were due to be flown from R.A.F. Benson last Tuesday.

BUTLER PLANS.—The former chairman of Butler Air Transport, Mr. C. A. Butler, proposes to set up a composite employee company in conjunction with Continental Airlines. He hopes to lease three Britannias or Viscounts about the end of this year and to buy six Caravelles in 1960.

C.P.A. TO TOKYO. — Canadian Pacific Airlines' Britannia 314 services to Tokyo are due to start on August 24 and on Tuesday of this week (August 12) C.P.A. were due to make a proving and training flight over the route from Vancouver with five full flight crews. After reaching Tokyo the Britannia 314 was to make a series of demonstration flights.

D.H.121 ORDER APPROVED.—On August 1 the Minister of Transport and Civil Aviation announced the approval of the purchase by B.E.A. of 24 D.H.121 short-haul jet transports for delivery between 1964 and 1966.

SWISSAIR RESULTS.—A variation from the general trend is shown in Swissair's results for the first six months of this year. Revenue tonne-kilometres increased, by comparison with the figures for 1957, by as much as 25%—including a remarkable rise of 36% in freight traffic. Nevertheless, the revenue traffic did not keep pace with the capacity offered, which increased by 35%, and the result was that the load factor fell to 57.6% from the figure of 62.2% for the same period of 1957.

PARIS-MOSCOW.—On August 3 Air France started their services to and from Moscow.

NEW IATA MEMBER.—REAL Aerovias Nacional, which now operates international services including those between Brazil and the United States, has become an active member of the International Air Transport Association.

Military Aviation Affairs

EX-AYRSHIRE.—The R.A.F. recently took delivery of 12 Scottish Aviation Twin Pioneers. The first twin-engined fixed-wing STOL aircraft to enter service with the R.A.F., it is in quantity production.

BURTONWOOD CLOSING. — The U.S.A.F. Military Air Transport Service terminal at Burtonwood is to be transferred to R.A.F. Mildenhall early next year to bring it nearer to other American bases. Later in the year flying will end altogether at Burtonwood when the 53rd Weather Reconnaissance Squadron is moved to another base.

VOODOOS' FLIGHT.—Seven McDonnell Voodoos of the U.S.A.F. made a non-stop flight from Bergstrom A.F.B., Texas, to Bentwaters, Suffolk, on August 10. During the 5,292-mile flight the aircraft were refuelled twice and flew at about 600 m.p.h. They have come to this country in preparation for the arrival of three squadrons of Voodoos which will be based at Bentwaters later this year. Piloting one of the seven aircraft was Maj. Adrian Drew, official holder of the World's air speed record in a Voodoo.

BATTLE OF BRITAIN SERVICE.—The annual Battle of Britain Thanksgiving Service will be held this year in St. Paul's Cathedral on Sunday, September 21. Applications for tickets should be sent to the Under-Secretary of State, Air Ministry (S.4c), Whitehall Gardens, London, S.W.1, by September 5.

News About People

CLUB VISITORS. — Left, air cadets from France, Holland, Sweden and Turkey visited Croydon Aerodrome on August 10 as part of the cadet interchange programme, and were guests of the Surrey Flying Club. A brief report is on page 215.

Photograph copyright "The Aeroplane"

LONG FLIGHT.—Capt. Pat Boling, 43, is claiming a new distance record for light aeroplanes. In a Beechcraft Bonanza he flew non-stop from Manila, Philippines, to Pendleton, Oregon—nearly 7,000 miles in 45 hr. 42 min.

FARNBOROUGH EXTRA. — On September 1 an S.L.A.E. main lecture will be given by Mr. D. J. Lambert, A.M.I.Mech.E., A.F.R.Ae.S., assistant general manager, development, of Vickers-Armstrongs (Aircraft), Ltd., on "The Engineering Development of Turbine Aircraft as Influenced by World Traffic Patterns." It will be held in the main assembly hall of the R.A.E., Farnborough, at 18.30 hrs. Mr. I. J. Gregory will be in the chair. Details of admission can be obtained from the general secretary, S.L.A.E. Secretariat, 1 High Street, Maidenhead, Berks.

S.B.A.C. SCHOLARSHIPS. — The scholarship selection committee of the S.B.A.C. has awarded 1958 University Scholarships to the following seven candidates: J. A. Radcliffe (Handley Page, Ltd.); N. A. Barrington (Bristol Aircraft, Ltd.); J. R. Craig (Bristol Aero-Engines, Ltd.); P. E. Hall (A. V. Roe and Co., Ltd.); J. Humphreys (A. V. Roe and Co., Ltd.); H. Holtby (Blackburn and General Aircraft, Ltd.); Q. Wilson (Scottish Aviation, Ltd.). With the exception of N. A. Barrington, who has been accepted by Imperial College, the students will go to the College of Aeronautics.

COURTENAY'S NEW POST. — William (Bill) Courtenay, well known for many years as aeronautical journalist and globe-encircler, has been appointed European Director of the Sydney *Daily Mirror* and *Truth* of Australia. His office opened in Fleet Street on August 11.

DUNSTABLE PRIZEWINNERS.—Standing, left to right: Flg. Off. F. T. Cretney, Dr. D. B. James, Wg. Cdr. N. W. Kearon, Sgt. A. W. Gough, C. A. P. Ellis, D. O. Hiscox, C. Wills (a year's subscription to THE AEROPLANE). Front row: R. D. Ruffett, A. W. Erskine (a year's subscription to THE AEROPLANE) and Flt. Lt. R. A. Manns. See also p. 240.

Photograph copyright "The Aeroplane"

Air Transport

Independent DC-6As

LAST week and week-end two Douglas DC-6As arrived in England—one for Eagle Aviation and one for Hunting-Clan Air Transport. The first of them, one of two for Eagle, arrived at Blackbushe Airport on August 8. The second, one of two for Hunting, arrived at London Airport on August 10. Both had been ferried from Santa Monica, that for Hunting by Capt. L. B. Greensted, M.B.E., the company's operations director.

Eagle's DC-6As (G-APOM and G-APON) are to be used on general flying duties; Hunting's DC-6As (G-APNO and G-APNP) are intended primarily for the Africargo network of all-freight services to and from Africa, replacing the Yorks which have been used on this service since 1955. They are being fitted out so as to be rapidly convertible for use as passenger aircraft, with seating capacities up to 105 when used for general long-haul charter and inclusive tour work.

Confirming a Navaid Policy

FOR some little time now it has been known that the Ministry of Transport and Civil Aviation were about to issue a new information circular in which their policy in relation to short-range navigational aids would be re-stated.

This circular, No. 67 of 1958, has now appeared and is, in fact, a developed version of that (No. 110) issued in 1955, in which a policy of support for the Decca area-coverage system, subject to its further development, was outlined.

The new circular explains that air traffic over the U.K. is increasing steadily and that the introduction of turbojet aircraft "will soon give rise to additional and complex air traffic problems.

"As a result of considerable study of the present and future operational requirements the M.T.C.A. is convinced that, if air traffic control is to continue to operate efficiently, expeditiously and with no reduction in the standard of safety hitherto maintained, the following requirements must be satisfied: (a) The maximum utilization of controlled airspace must be achieved; (b) a high capacity route structure must be provided; and (c) aircraft must be given the greatest possible freedom in the vertical plane.

"To meet these requirements it is essential that the basic navigational system should provide coverage at all altitudes, permit highly accurate navigation in any direction within its service area and that the information it provides should be presented visually in the cockpit so that a pilot can follow defined routes and carry out the manœuvres and instructions of A.T.C. readily and with precision.

"The VOR, NDB, radio range and similar systems cannot," the information circular continues, "provide these facilities. Their basic accuracy is such that wide separation minima must be imposed between aircraft using them resulting in low airspace utilization and consequent delays to traffic. Furthermore, their presentation to pilots is such that traffic patterns based on them are frequently difficult to fly accurately. When these aids are used as overhead reporting points in busy areas they cause traffic congestion and further delays.

"Moreover, since they are used to mark routes and holding points, any changes of airway routings, holding points or the introduction of new airways necessitate either the redeployment of the aids or the introduction of additional facilities. In metropolitan areas particularly, new sites for such facilities are difficult to find and usually take a considerable time to acquire. In some cases the ideal location cannot be used as the terrain is unsuitable.

"Nevertheless, since VOR is the present ICAO standard aid for short-range navigation, a limited number of VOR beacons is being installed to provide track guidance along the U.K. national airways. As this programme advances a number of radio ranges and beacons at present operating in the U.K. will be progressively withdrawn. Full details of any proposed changes will be promulgated well in advance of their implementation."

The circular adds that, where cover is available, GEE is accepted as adequate for flying the present U.K. airways, but that it is not U.K. policy to provide 1,000 Mc/s. DME or VORTAC. However, a limited number of 200 Mc/s. DME installations will be deployed to meet certain B.O.A.C. requirements.

The circular concludes with a reaffirmation of faith in the Decca system following extensive trials during the past six years, stating categorically that this is the one which best meets the A.T.C. requirements. It allows, the circular explains, optimum flexibility in the organization and reorganization of the air route structure and its accuracy is such that smaller lateral track separations can be used than have hitherto been possible. It also provides vastly improved means of navigation in the departure, en route, holding, descent and approach phases. In addition the pictorial presentation enables pilots to execute A.T.C. procedures readily and accurately and provides them with continuous visual confirmation that they are doing so. Decca and the long-range Dectra can be integrated to form a comprehensive navigational system using a unified airborne receiver.

The Ministry intend to introduce new Decca procedures, including special climb-out routes additional to those already existing in the London F.I.R.

CUBANA BRITANNIAS.—Compania Cubana de Aviacion, S.A., of Havana, has ordered two more Britannia 318s, to make a total of four, at a cost of $14 million. The first two were ordered in May, 1957, and delivery begins at the end of this year; the re-order follows the demonstration tour made by a Britannia 305 in Cubana colours and shown here at Lisbon Airport. Bristol and Cubana have also announced plans to set up a joint engine overhaul base at Havana.

American Airlines' New Convairs

FOLLOWING the brief reference to the new turbojet purchases by American Airlines in last week's issue (p. 192), more information has become available about the 25 Convairs which are on order.

These are, in fact, new variants of the 880 turbojet transport and are known as the Type 600. The 600 has obviously been designed to meet the specific requirements of the short-medium-haul carrier with varying stage-distances. American have ordered 25 of them, with 25 more on option. First delivery is to be made in June, 1961, and the first flight of the new variant is scheduled for August, 1960.

The 600 has three main features which distinguish it from the 880. The first is the use of turbofan engines—General Electric CJ-805-21s—developed from the J-79; the second is a very high maximum landing weight—180,000 lb. by comparison with the 880's 130,000 lb.—so that a succession of intermediate landings can be made without refuelling; and the third is the use of "leading-edge devices" and new flaps to reduce the approach and landing speeds. The 600 will have a fuselage which is 139 ft. 5 in. in length by comparison with the 880's 129 ft. 4 in. and there will be capacity for 90-120 passengers

This artist's impression of the American Airlines' Convair 600 shows the approximate position and shape of the area-rule projections or fairings fore and aft of the trailing edges.

according to layout. The maximum gross weight is 238,200 lb., or 59,700 lb. higher than the quoted figure for the 880.

Information from Convair gives the maximum cruising speed as 551 knots and the Mach limitation as 0.91; the 880's Mach number has been quoted at 0.89. The higher figure has been helped by the use of fairings aft and forward of the wing trailing edges. This is a fairly modern form of area-ruling such as can be applied to a transport aircraft in which major changes in the fuselage-wing combination shape are not practically possible. The protuberances slow down the airflow ahead of the shock-waves and weaken them so that the basic separation is reduced. In the 600 there appear to be two of these bodies on each side of the fuselage, inboard and outboard of the inner engines.

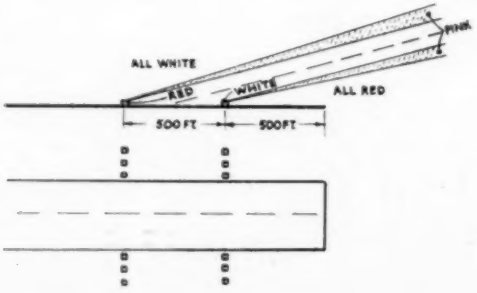
The turbofan is, in effect, a single-stage, aerodynamically coupled turbine-cum-compressor at the rear of the basic engine. The turbine blades extend outside the basic turbojet diameter to act as a fan which provides by-pass airflow. General Electric have claimed 35% increased thrust (which is of the order of 15,000 lb. static) and 10% improved economy for the turbofan engine.

The Boeing 720s ordered by American are designated 720-023s and will be delivered in 1960 and 1961. Arrangements have been made to lease the JT3 turbojets for the 720s from Pratt & Whitney and the CJ-805-21s for the Convairs from General Electric. The Allison 501D turboprops for the 35 Electras already on order have also been leased.

Visual Glidepath Indicator

FOLLOWING the description of the new visual glidepath indicator developed by R.A.E. Farnborough which appeared in THE AEROPLANE of July 25 (page 125), a model of the system has been demonstrated by the Ministry of Supply. Since seeing this, further details can be given of the aid, which has a number of advantages over the earlier three-colour approach-angle lighting system.

As already recorded, it consists of two light bars, about 30 ft. wide, on each side of the runway at the fore and aft limits of the desired touchdown area. Each light bar comprises three units of three lamps, giving a total of 36 lamps in the complete layout.



The lamps are of the sealed-beam type producing a beam of light 8° in depth and 30° in width, with a red filter making the lower half of the beam red. Between the red and white sections there is a ½° band of pink light. Each unit consists of a rectangular box with a 4½-ft. horizontal slit through which the beams of the three lamps are projected at a set glide-path angle in the approach direction.

Besides marking the touchdown area, the two-bar installation informs the pilot when he is approaching the runway along a descent path which is between certain safe limits and provides roll guidance prior to touchdown. If the aircraft is too low, the pilot sees two red bars; if too high, he sees two white bars. Within the desired approach-angle limits the pilot will see the furthermost bar red and the nearer bar white.

A typical installation, for an airport used by medium and large transport aircraft with an approach glidepath of 3°, could have the first pair of light bars 500 ft. along the runway from the threshold and the second pair 500 ft. beyond the first pair. With these dimensions and the two light bars set at slightly different angles (say ¼°) a constant-depth (25-ft.) visual glidepath is projected. Applying this to a large transport where the pilot's eyes are some 20 ft. above the main wheels in the approach attitude, an aircraft on the lower limit of the indicated safe glidepath, and without being flared-out immediately prior to touchdown, would strike the runway approximately 100 ft. beyond the threshold.

From tests made at Farnborough it has been found that the indicator lights can be seen and used under the worst daylight conditions—in haze and when approaching up-sun—at ranges of more than two miles. At night, five miles is the normal figure. The visual glidepath indicator can be used down to the threshold of the runway.

The first operational test installation is now at Blackbushe, where the two light bars are fitted on one side of the runway (08) only. It is proposed, regardless of the actual siting dimensions, that the correct approach angle on any runway should present the same picture to the pilot—so that the length of one light bar will equal the apparent distance between the furthermost and nearer light bars.

Tourist to Economy

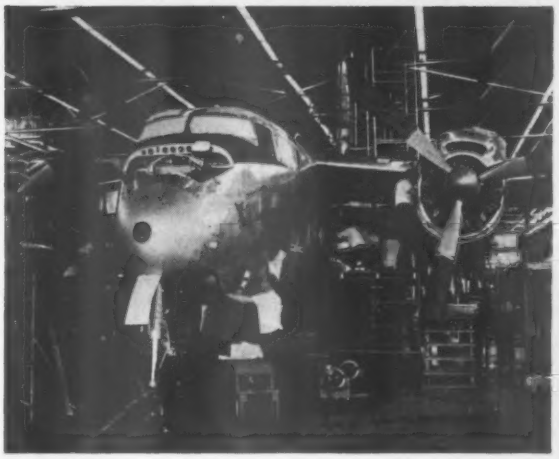
WHEN the economy-class fare was introduced on the North Atlantic in April many people wondered whether this new class might finally cause the older tourist class to be superfluous, if not an anachronism.

The first signs of this effect appeared last week with an announcement from K.L.M. that they were proposing to abolish the tourist class on all their non-stop DC-7C flights and to use the cabin space for an increase in the economy-class accommodation.

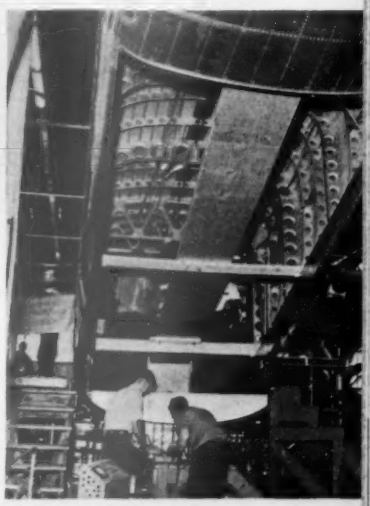
During the period between April 1, the starting date for the new fare, and July 31 this operator carried 40,400 tourist- and economy-class passengers over the Atlantic, compared with 30,200 tourist passengers in the same period of 1957. A detailed investigation has shown that the low fare was attracting a new category of passenger in a lower income-group.

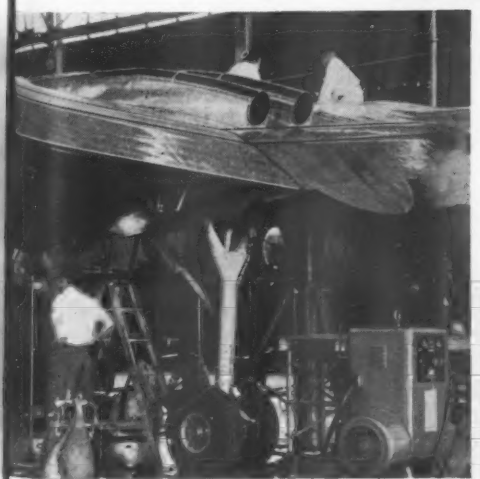
Caribou Construction

A production line of 17 *DHC-4 Caribou utility transports is under way. The prototype first flew from Downsview, near Toronto, on July* 30, *piloted by chief experimental test pilot, George Neal, for an hour. Seven aircraft are ordered, five for the U.S. Army and two for the Canadian Army.*



Above, final assembly : the second aircraft is already on the line. The first is not fitted with operative slats —their value will be determined after completion of flight tests. Fibreglas plastic is used in the nose section, door and window frames.





Above, three-blade Hamilton-Standard 43D50-349-7059A-0 automatic full-feathering constant-speed propellers, of 13 ft. 1 in. diameter, have been specially designed for the Caribou. The engines are 1,450-b.h.p. Pratt & Whitney R-2000s.

Right, the full-floor-width aft loading doors with ramp measure 73 in. by 75 in. The floor is 45 in. from the ground at truck-bed height.

Howard Levy photographs

Above, the dual augmenter-exhaust outlets are apparent in this view, also the two-stage landing gear, which is rugged enough to allow an 840 ft./min. descent. Hydraulics are by Jarry, wheels and brakes by Goodyear.

Right, the double flaps, similar to the Otter's, are seen here in the half-down position. The characteristic profile of the fuselage is also apparent. The overall height of the aircraft is 31 ft. 8 in. The span is 96 ft., the length, 68 ft. 10 in.

THE FIGHTING SERVICES

Senior R.A.F. Postings

AIR VICE-MARSHAL J. GRANDY, C.B., D.S.O., is to become Assistant Chief of the Air Staff (Operations) in November. Commanding the Task Force "Grapple" since December, 1957, Air Vice-Marshal Grandy was previously Commandant of the Central Fighter Establishment, R.A.F. West Raynham.

The new commander of Task Force "Grapple" is to be Air Vice-Marshal T. A. B. Parselle, C.B.E., at present Commandant of the R.A.F. College, Cranwell. Deputy Director of Bomber Operations at the Air Ministry from 1950 to 1953, Air Vice-Marshal Parselle then served for two years in Australia as Commandant of the R.A.A.F. Staff College, Point Cook.

Gp. Capt. D. F. Spotswood, C.B.E., D.S.O., D.F.C., has been appointed Commandant of the R.A.F. College, Cranwell, as from September, with the acting rank of Air Commodore. Deputy Director of Plans at the Air Ministry since October, 1956, he previously commanded R.A.F. Linton-on-Ouse.

Britannia Shield Contest

THIS year the annual competition for the Britannia Shield will be held from October 27 to 29, with the boxing finals at the Empire Pool and Sports Arena at Wembley on the last day. For this 13th competition (the first took place in 1946) it is expected that athletes from the Armed Forces of Belgium, Norway, Canada, the Netherlands (1957 winners), and the U.S.A.F. in Europe will compete with the R.A.F.

Fencing will be held at R.A.F. Uxbridge; shooting at Bisley; swimming at Watford, and the boxing semi-finals at R.A.F. Uxbridge. All profits from the competition go to the Britannia Shield Scholarship Fund administered by the R.A.F. Benevolent Fund.

Jungle Survival

COMMANDED by Flt. Lt. J. Gant, D.F.M., the F.E.A.F. tropical survival school at R.A.F. Changi, Singapore, starts its 50th course on August 18. Since it came into operation in March, 1956, nearly 1,000 personnel of the Commonwealth and South-East Asia Treaty Organization armed forces in the Far East have received instruction on jungle survival.

Of the course, five days are spent in the Malayan jungle in conditions which crashed or baled-out aircrew would encounter. Pupils learn the techniques for parachuting into tall trees, climbing down safely, and establishing camps and shelters. They study plant life, jungle navigation, trapping, and fishing, bamboo cutting and jungle cooking. Aircrew are also briefed on animal, fish and insect life encountered in the jungle and on the Malayan aborigines' customs.

OUT EAST.—Squadron Leader J. R. Linford, the present C.O. of No. 81 Squadron which, as recorded below, has now completed 10 years of anti-terrorist photographic reconnaissance operations in Malaya.

Malayan Reconnaissance

EQUIPPED since 1946 with Spitfires, Mosquitos and Meteors, No. 81 (Photographic Reconnaissance) Squadron (Sqn. Ldr. R. J. Linford) has now completed 10 years of anti-terrorist photographic operations in Malaya, during which time it has flown 8,958 operational sorties in support of the ground forces. In addition, the Squadron's aircraft have undertaken routine survey work in several areas of the Far East, covering 49,000 square miles of territory.

On July 9, 1948, one of the Squadron's Spitfires made its first operational flight in direct support of the anti-terrorist forces. Three months later its Mosquitos began an emergency survey of Malaya, completing it by August, 1950. Its basic photographic coverage of Malaya being completed in September, 1953. In November, 1953, Mosquitos replaced the Spitfires, the last operational sortie by a Spitfire being made on April 1, 1954, by Sqn. Ldr. W. P. Swaby, then the C.O. On December 15, 1955, the last Mosquito flight was made and Meteors took over.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Group Captains: A. A. Fletcher to the M.o.S.; M. W. B. Knight, D.F.C., to R.A.F. Neatishead to command.

Wing Commanders: A. P. Dart, D.S.O., D.F.C., to R.A.F. Ballykelly for flying duties; J. S. Hando to No. 25 M.U. for administrative duties; K. C. C. Hicks to Headquarters, 2nd T.A.F., for administrative staff duties; E. G. F. Hill to the R.A.F. Staff College, Bracknell, for directing staff duties; J. R. Ramshaw, D.F.M., to R.A.F. Patrington; W. W. T. Ritchie, O.B.E., A.F.C., to R.A.F. Watton to command the Flying Wing; A. P. H. Slogrove to No. 92 M.U. to command; G. Tate, O.B.E., D.F.C., to R.A.F. Neatishead; K. H. Wallis to Headquarters, Fighter Command, for technical staff duties; E. J. Wicht, D.S.O., D.F.C., to R.A.F. Stradishall to command the Administrative Wing; T. S. Wilkinson to No. 217 M.U. to command.

Squadron Leaders: B. G. Lock, A.F.C., to Air Ministry for duty in the Department of the Air Member for Personnel (with acting rank of Wg. Cdr.); J. F. Pinnington as Air Attaché, Helsinki (with acting rank of Wg. Cdr.).

LAST LINE-UP.—One of the last acts of No. 1 Squadron (then commanded by Sqn. Ldr. R. S. Kingsford) before the recent handing over of the Squadron Standard to No. 263 Squadron at Tangmere was to repeat the Squadron's traditional tail-to-tail line-up with Hawker Hunter F.5s. This pose was first photographed at Clairmaris, near St. Omer, in July, 1918, when No. 1 Squadron was equipped with S.E.5As.

Lunar Probe

by James Strong

NO one can grumble—least of all genuine space enthusiasts—at the rattling pace with which the preliminaries to space-flight are being hustled along. The 1957-58 IGY Satellite Programme, which lazed in the doldrums to start with, and was then galvanized into breathless activity by the ascent of Russia's sputniks, looks like ending in an all-out, devil-take-the-hindmost assault on the Moon.

Dyed-in-the-wool (pre-IGY) space veterans are hard-put these days keeping up with the plethora of schemes for opening up the highways to space. Their brains bulge as they try to assimilate the latest news concerning photo-reconnaissance satellites, million-pound thrust motors and manned space-capsules of assorted shapes and sizes.

Behind the glass security curtains of the New World loom the shadowy outlines of Man's latest toy—the lunar probe. Behind the iron curtain of the Slav World stand others—not so visible. A calculated indiscretion, hurriedly shushed by Pentagon officials, revealed last June that the U.S. Air Force would attempt to launch three lunar probes this year—in August, September and October.

Not to be outdone by such blatant advertising the U.S. Army Ballistic Division promptly let it be known that, ". . . in the rocket's red glare, they (too) would be there. . .," and with two more probes to boot. The U.S. Navy, who have trouble enough on their hands teaching Vanguard to behave, are keeping discreetly quiet and trying not to get involved. Why should they, anyway? There's no water on the Moon.

By not so much as a peep have the Russians let on that they suspect anything out of the ordinary is happening, an omission that to Pentagonal ears is significantly foreboding. With a ton and a quarter of Sputnik III circling the Earth alongside two 30-lb. Explorers and a diminutive "grapefruit" Vanguard, the portents are distinctly ominous. Rumour even says the Soviet Union made an effort to reach the Moon last March, but that the venture proved unsuccessful.

Since the latest Moon Project looks as though it will be as much an instrument of propaganda as a goal of scientific desire, the choice of the term "probe" is somewhat a misnomer. The last thing anyone wants to do, so it seems, is to prod the Moon. To use the lunar mass as an atomic testing ground, or even to besmirch the pristine surface with anything so vulgar as soot is tantamount to scientific vandalism. According to some, even the probe should be thoroughly disinfected in case it accidentally transports a coach-load of earth-type germs that might colonize the Moon prematurely.

Still more specious is the political argument that it is much more of an achievement to circle round the Moon and come back with data than actually strike the surface with a magnesium flash or dye-marker. Unfortunately for this thesis the uneducated masses of the World will regard a probe that has "missed" as a flop. What is more, they are right. The first power that proves it can hit the Moon is going to collect all the kudos, and to argue otherwise shows poor psychology. Why not admit that it is much more difficult?

Even more obscure seem to be the objectives of the lunar probe, though to be strictly fair they have not yet been given official backing. The aims are said to be:—

(a) To determine accurately the Moon's mass.

(b) To ascertain the strength of the lunar magnetic field.

(c) To photograph the Moon at short range.

(d) To find if there is a lunar atmosphere.

With the possible exception of (b), all the other information is already available, and it is questionable whether a knowledge of (b) is significant to any future Man-on-the-Moon programme, though it may interest geophysicists and selenographers who have not the patience to wait until they get there.

Circum-lunar Orbits

Many parameters enter into any calculation of circum-lunar trajectories, and it will certainly be necessary to call in the assistance of electronic computors for their speedy solution.

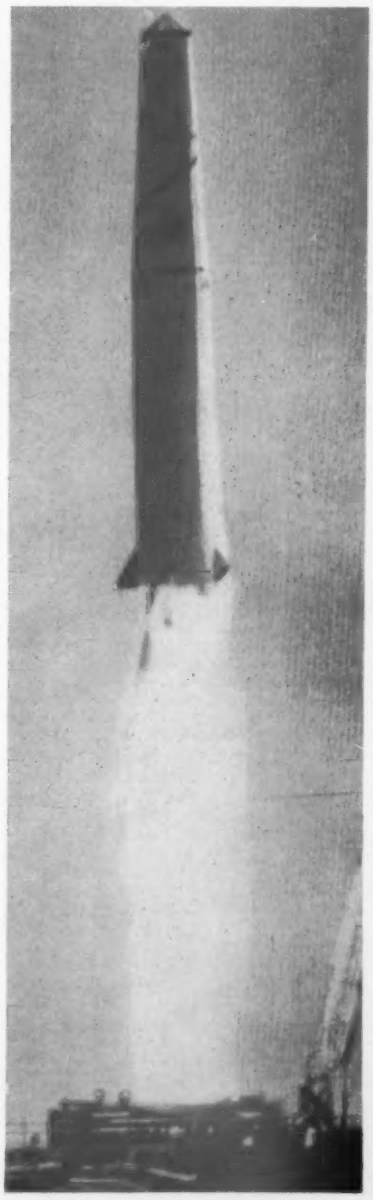
The dynamic performance of the boost vehicle itself, dependent as it is on the weight, thrust and burning time of each stage, can be estimated by normal methods. But to this must be added corrections due to the gravitational attraction of the Earth, Moon and Sun, their planetary velocities, and relative position to the probe as the trajectory unfolds. Earth rotation will also figure in the calculations before the instant of launch, the probe heading at final burnout (lead angle) and tolerance to error are known. Innumerable trajectories must be computed in advance before the one that offers the greatest scope for success is chosen.

Even then, those who make the calculations are under no illusions as to the chances. They merely hope that when the final ounce of thrust has been extracted from the last stage, and the probe is committed to orbit, it will not be far off course. Even the slightest deviation becomes magnified by the phenomenal distance the probe has to coast before it reaches its apogee and begins to return.

To say therefore that a circum-lunar journey is more difficult than to hit the Moon is sheer nonsense. The Moon is an elusive target. There is always the risk of a direct hit or even a capture orbit being achieved accidentally, but a miss is a much more probable result, and not even a circum-lunar miss at that.

Consider what is involved before such an unlikely thing as a hit were to result. The probe has to be fired into an extremely long elliptic orbit, whose apogee must be at least 239,000 miles away if it is to embrace the Moon's path. It must be aimed so that at burnout its orbital axis subtends an angle of about 40° to the lunar sight-line, and it must be moving along its path at the exact speed necessary.

For this the probe must be accelerated



POSSIBLE PROBE-LAUNCHER.—One of the lunar probes may be launched with a Thor IRBM as the first element. In this picture a Thor leaves its launching pad with a flat type of nose cone specially designed to meet re-entry conditions.

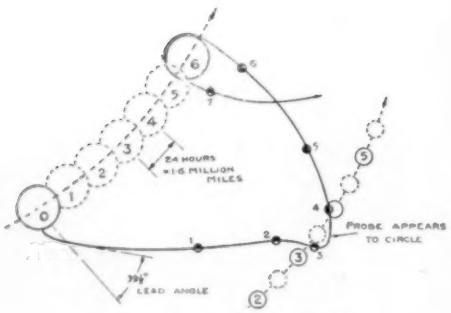


Fig. 1 (not to scale).

to 23,400 m.p.h. at burnout, after which its speed will steadily diminish all the way until, approaching its apogee, it may not be much more than 450 m.p.h. Since it has not at any time reached "escape velocity" (25,000 m.p.h.) it still remains within the ambit of the Earth's gravitational field, and must eventually fall back.

The Moon, on the other hand, orbits the Earth at 2,300 m.p.h., moving in the same direction as the Earth's rotation. It will therefore overhaul the probe at apogee with a relative closing speed of 1,850 m.p.h.

If the probe is late for the rendezvous it will be left behind, as remorselessly as the last bus departs leaving the midnight reveller stranded. If the probe is too early, its heading must lie truly along the Moon's path, and sufficiently far ahead, if there is to be contact. Should it arrive ahead of the Moon, but moving so as to intersect its path, the Moon's gravitational attraction will pull it into a hyperbolic orbit, increase the probe's speed and fling it past. Unless the probe can then brake the hyperbolic orbit into a capture ellipse (and there is no lunar atmosphere to assist this braking), or unless it can turn and accelerate so as to match the Moon's velocity, a direct hit is difficult to foresee.

The true circum-lunar orbit must therefore be one in which the probe appears to circle the Moon, but in which the Moon actually passes inside the probe's apogee at full speed (Fig. 1.). If the probe were, however, to pass so as almost to graze the Moon, at a relative speed sufficiently low, there is a chance that its orbit might describe a figure of eight. Collision courses are faintly possible, but not very probable without some controlled expenditure of thrust energy.

Moon Rockets

The circum-lunar probe will be launched straight up from the Earth's surface, reaching, as successive stages burn out and drop away, a velocity sufficiently high to allow it to coast the rest of the way to the Moon. This should take some three days. With the return journey taking slightly longer, the total orbital period will occupy 6½ days. Ideally, to gain the maximum assistance possible by using the tangential component of Earth rotation, the launch should take place at the equator. However, it is more expedient to launch from Cape Canaveral, Florida, because of its established testing and tracking facilities.

To attain this phenomenally high speed, 6,000 miles an hour faster than any previous satellite, a heavy three-stage rocket vehicle is proposed. The first stage will be the Douglas intermediate-range ballistic missile, Thor. The second stage will be the already-tried second stage of the Vanguard vehicle, designed by the Aerojet-General Corporation, California. Finally, the third stage, to which will be attached the probe instruments and radio transmitters, will be a sold-propellent rocket whose size and weight have not been disclosed.

Thor, of course, is the fully developed IRBM which is shortly to be set up on launching sites in the United Kingdom. It weighs 100,000 lb., has a body diameter of 100 inches and stands 65 ft. high. The propellents are liquid oxygen and kerosine, which are pumped to a gimbal-mounted Rocketdyne S-3 motor, rated at 165,000 lb. thrust.

The Vanguard second stage is also a bi-fuel rocket, burning unsymmetrical dimethyl-hydrazine (UDMH) and nitric acid (WFNA). Its rocket motor is likewise gimbal-mounted, controlled by a guidance system in the nose compartment.

Both rockets therefore have their own guidance systems; Thor's being of the radio/inertial type, whilst Vanguard has a stabilized gyro-platform and pitch-programmer. In the nose of the second stage Vanguard there is also a spin-up table that will be used for spin-stabilizing the unguided solid-propellent final stage and probe.

No details of the latter, or of the probe, have so far been revealed, beyond the fact that they are new designs. Nevertheless, it is not unreasonable to think that the motor will contain the new high-specific impulse propellent that was used for the final stages of the Explorer IV vehicle.

First Off?

Although the U.S. Air Force probe is expected to be the first to be launched (Sunday, August 17, between 06.00 hr. and noon has been announced as the date), the U.S. Army's hopes will be pinned to a vehicle similar to one which successfully launched three out of four Explorer satellites.

The main booster will be a modified Jupiter, though it is possible that this will be the later version of Jupiter (weighing 100,000 lb.) and not the ubiquitous Redstone used for satellite launching. Having a greater payload capacity, it would contain not only the guidance in its first stage, but also the spin-up "bucket" in which a cluster of solid-fuel Sergeants could be spun up and fired. These, if previous methods are anything to go by, will form the second, third and fourth stages, the final stage being another Sergeant containing the probe's payload of instruments in its head.

Assuming that a close approach to the Moon has been made, and that the probe is circumnavigating according to plan, what information can it pick up before returning Earthwards?

The interval during which it is in the Moon's vicinity cannot be more than an hour or two at most, and much will depend on the accuracy with which the data is correlated with the speed and distance of the probe from the lunar surface. At a distance of a quarter of a million miles it is rather optimistic to hope that radar will separate them, even though the Jodrell Bank 250-ft. diameter radio-telescope will be put to use. Reliance may have to be put on Doppler measurement of the probe's transmissions, a continuous plot of the trajectory and a series of timed photographic measurements.

If these methods are successful, and the true trajectory is computed, a knowledge of the probe's weight should permit calculation of the Moon's gravitational attraction from observed deviation to the probe's initial orbit. This would give the lunar mass. Were the probe itself to carry a miniature radar, it could conduct its own height measurements and transmit this information later if not possibly on the spot.

The strength of the lunar magnetic field could be recorded at various altitudes by using the proton-precession magnetometer developed for similar terrestrial survey work in Earth-satellites. This information would have to be taped and played back during the return journey at some opportune moment.

Perhaps the most fascinating proposal so far made is that a television camera in the probe should photograph the hidden side of the Moon. Several firms in the United States are said to be working on a project of this nature for incorporation in an Earth-orbiting photo-reconnaissance satellite (Pied Piper). For a weight of 25 lb. a crude picture transmitter can be made to work, consisting of a lens scanner, a 5-watt, 4-Mc/s transmitter and focusing apparatus. Attitude control for the satellite can also be provided for a further 40 lb.

It may be that one of these cameras will be used, though it is said that a "mechanical ground scanning device" developed by the Naval Ordnance Test Station, at Inyokern, is scheduled. Whichever is chosen the pictures will necessarily be crude in quality, but should they succeed it will mean that for the first time we shall know what lies on the other side of the Moon.

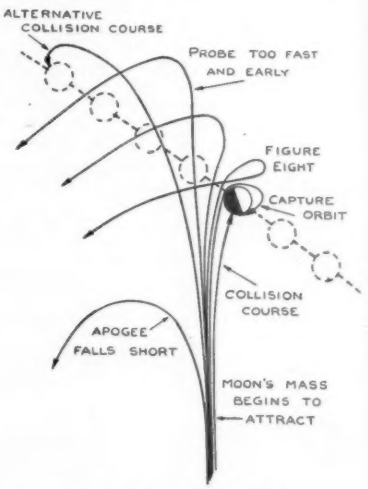


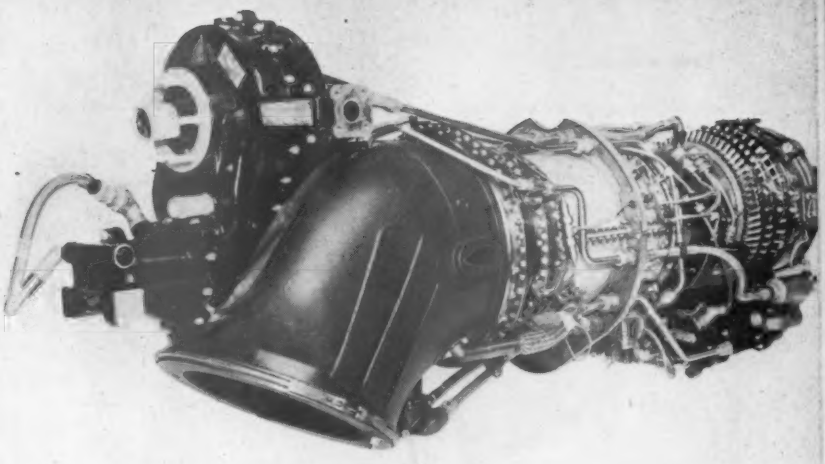
Fig. 2. Circum-lunar orbit.

This brings up the question of timing, for if the far side of the Moon is to be photographed it will have to take place when that side faces the sun. It means that this must happen when the Moon (to us) is new (August 15) and the moment of launching must be so ordered.

Conclusion

There could scarcely be—perhaps by the time this is in print—a more fitting finale to the International Geophysical Year than the launching of a successful circum-lunar probe. It will round off neatly a short, but exciting chapter on "Earth-satellites" and hint at still more incredible adventures to come as the story of spaceflight unfolds. The title of the next chapter we can even guess. It will be —"Man in Space."

Introducing the Gnome



REQUIREMENTS for a 1,000-s.h.p. shaft-turbine engine as a helicopter power unit—with turboprop possibilities—are now almost universal. Consequently, there is now a distinct contest taking place among British aero-engine manufacturers for the obvious advantage of being first with a production engine of this type. The race to be first is all the more important because it is clear that, for economic reasons, there can be but one such engine produced in the United Kingdom.

That the de Havilland Engine Co., Ltd., has a licence to build the 1,000-s.h.p. General Electric T58 as the D.H. Gnome came as no real surprise. The British manufacturer has exchanged technical information with the American concern since 1951 and has evidently paid close attention to the development of the T58. This engine passed its type-test in October last and has found an increasing number of applications in both rotary- and fixed-wing aircraft in the United States.

A development programme is the most costly and time-consuming part of the history of any aero-engine. The manufacturer must plan design and development of any new type of engine according to existing commitments, to future market needs and to existing engines of the particular type under consideration. It may well be that realistic delivery dates and a guaranteed performance are the deciding factors in favour of taking on the licence-production of an existing engine, rather than "jumping in off the deep end" and starting with an entirely new design on a clean piece of paper.

By taking on an established and tested design de Havillands have cut out several years of development and will have Gnomes coming off the production lines when they might otherwise have just got to the stage of running a new engine for the very first time. It is expected that the D.H. Gnome D.Ge.1 will make its first run in March of next year.

The most significant data of the Gnome are its low weight and extremely high power/weight ratio. For a power of 1,000 s.h.p. the weight is 275 lb., or 350 lb. with gearbox. the corresponding power/weight ratio being 2.86 : 1 with gearbox. Development potential is at least 50% more power for an even better specific fuel consumption, at present 0.67 lb./s.h.p./hr. for cruising. The Gnome will be available in either single or coupled form.

Details of the Design

The Gnome is a free-turbine engine, the power surplus to gas generator requirements being passed through a free power turbine and used to drive a gearbox. This has the enormous advantage for helicopters that a weighty clutch is not needed and it is a fairly straightforward job with this engine to achieve a constant-speed helicopter rotor by variation of power turbine speed.

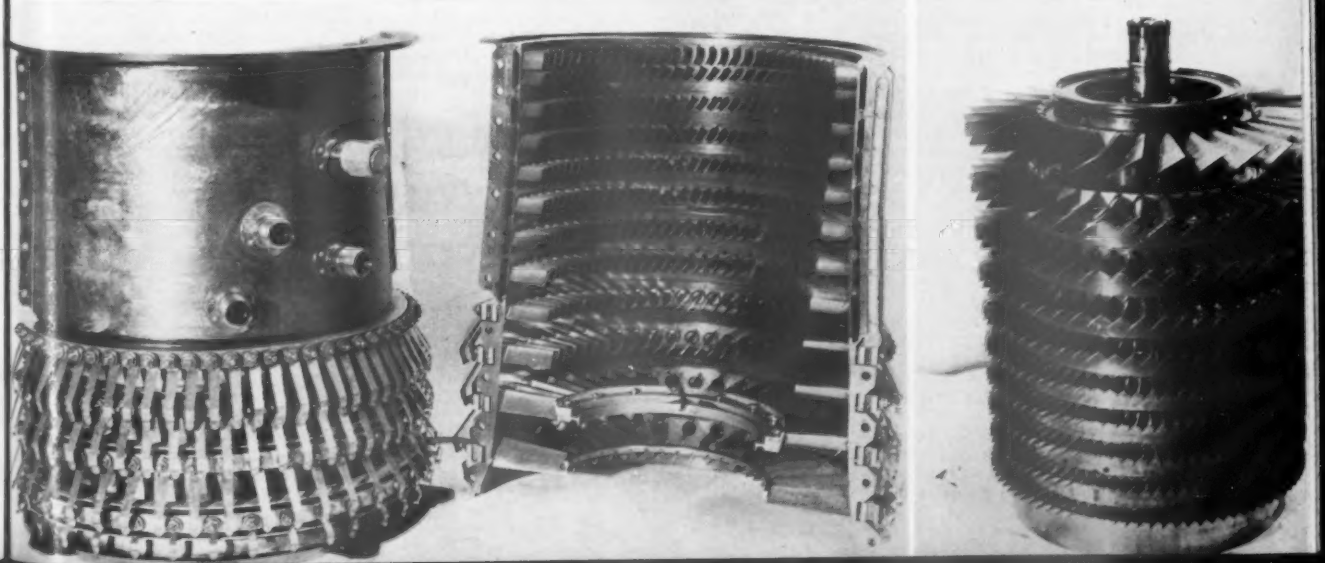
The engine consists of two main sections, the gas generator and the power turbine cum gearbox unit. The gas generator has a 10-stage compressor, a single annular combustion chamber and a two-stage turbine. The rotor is mounted on three bearings of which the centremost, a ball bearing, takes thrust loads. The single-stage power turbine is mounted on a separate two-bearing shaft—a front, roller bearing and a rear, ball bearing for thrust loads—with only a gas link to the gas generator.

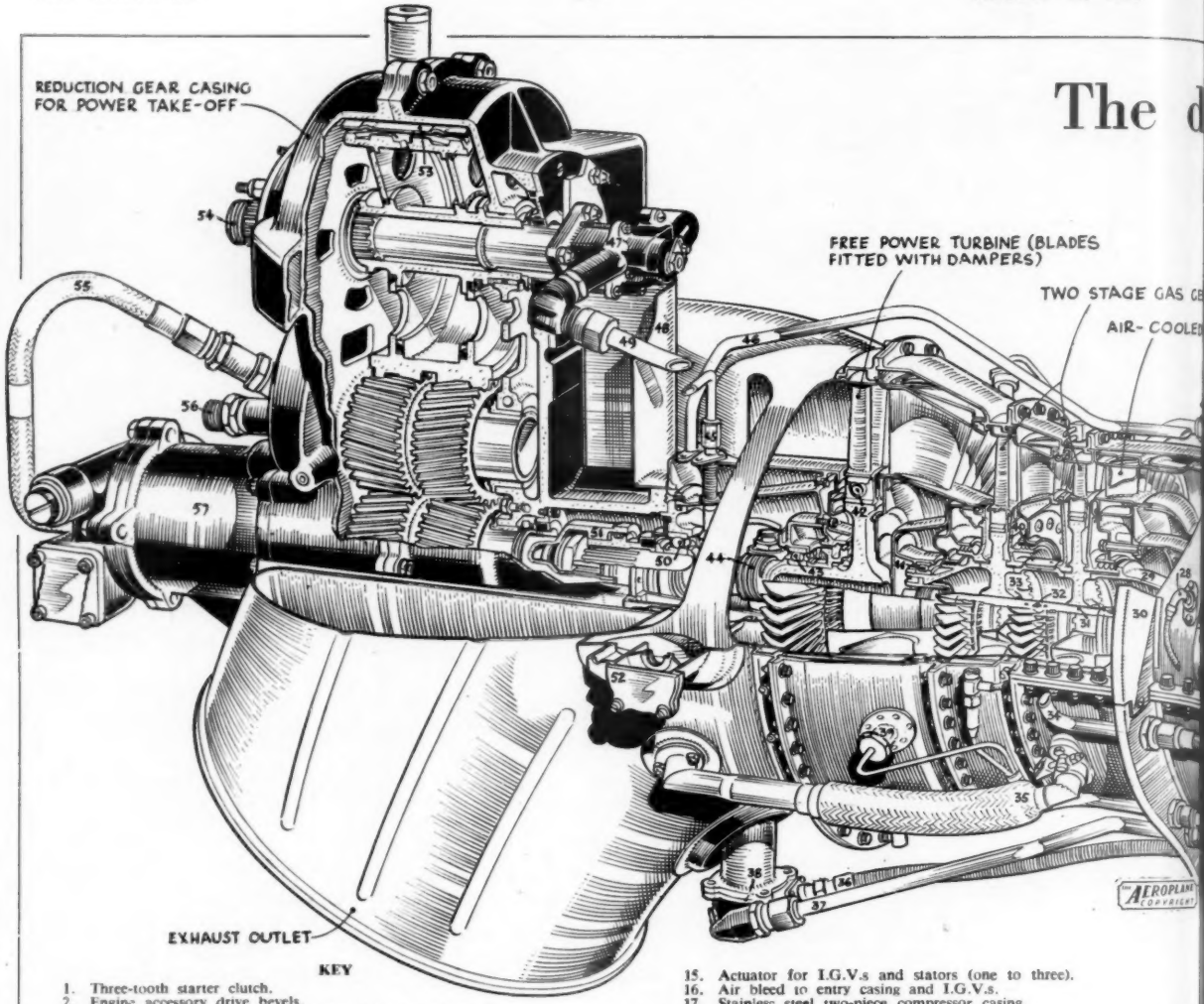
Starting at the front of the engine, the integral intake duct and front frame has four struts in the annular duct and is cast in aluminium alloy. It has an integral front-bearing housing and anti-icing air passages. Engine-mounting pads are located outside the two side struts and the top strut. On the hub of the front frame is a starter pad through which the compressor rotor shaft is driven by a three-toothed dog clutch.

Under the front frame is mounted the accessory drive gearbox which is driven by a radial shaft (S.98 steel) and spiral bevel gears (S.107 case-hardened steel). Of the two rearward-facing drive-pads one is for the fuel pump while the other drives both the oil pump and the gas generator tacho-generator. A forward-facing drive-pad is for a centrifuge-type fuel filter. An oil-filter housing is cast integrally with the gearbox casing.

For a very high efficiency engine of low weight it is necessary

COMPRESSOR COMPONENTS.—Inlet guide vanes and the first three stages of stator blades of the 10-stage compressor are variable-incidence. The compressor rotor is shown inverted, relative to the stators.





KEY

1. Three-tooth starter clutch.
2. Engine accessory drive bevels.
3. Aluminium alloy air intake casing, with heated struts.
4. Gas-generator front roller-bearing.
5. Oil filter.
6. Engine accessory gearbox.
7. Oil pump.
8. Tacho-generator.
9. Igniter box.
10. Stator ring with brazed-in blades.
11. Labyrinth balance seal.
12. Stator actuating ring (first three stages, and I.G.V.s).
13. Stages one and two compressor blades with twin-tang fir-tree roots.
14. Stages three to 10 compressor blades with circumferential dovetail roots.
15. Actuator for I.G.V.s and stators (one to three).
16. Air bleed to entry casing and I.G.V.s.
17. Stainless steel two-piece compressor casing.
18. Air impeller for turbine cooling.
19. Final-stage stators and exit guide vanes.
20. Centre bearing breather pipe.
21. Combustion chamber front support
22. Fuel nozzle and manifold.
23. Gas-generator centre ball-bearing.
24. Air splitter.
25. Combustion chamber primary air holes.
26. Fuel flow divider.
27. Rear compressor frame.
28. Igniter.
29. Turbine front shaft.
30. Firewall.
31. Centre
32. Turbine
33. Turbine
34. Bearing
35. Air bleed
36. Flexible

to have a high overall pressure-ratio with a two-spool layout or a single spool with multi-stage axial compressor. In choosing the latter as the most suitable for this type and size of engine, its designers avoided the undesirable inflexibility of such a compressor by introducing variable-incidence inlet guide vanes and stators.

The pressure-ratio of the Gnome compressor is 8.3 : 1 at maximum power. The inlet guide vanes and the first row of stator blades are shrouded. In addition to the guide vanes, the first three stages of stators are of variable-incidence to increase the compressor stall-margin during starting. When the engine is to be started, the variable-incidence vanes and stators are closed 30° from the nominal "open" setting. They are linearly opened-up with engine speed until they reach the "open" position at 85% full speed of the compressor.

Some unusual features of the compressor mechanical design are noteworthy. The last eight rotor stages are carried on a one-piece spool machined from a Rex 448 forging. The Rex 448 rear shaft is bolted to the spool at the outer diameter and is located by a rebate with an interference fit. The forward shaft, also in Rex 448 material, and second-stage wheel are in unit and are bolted to the forward end of the spool at the outer diameter, this shaft-to-spool connection also being an interference fit.

The first-stage wheel is overhung from the second-stage wheel. It carries a metal-to-metal labyrinth seal to form the outer seal of the balance-piston cavity.

Compressor rotor blades are in S.61 chrome-alloy steel and the stators are of the same material. First and second stages of the rotor blades have axial root retention of the twin-tang "fir-tree" type. The third to the 10th stages are retained in the one-piece spool by circumferential dovetailing, plateaux on the blades maintaining the smooth surface of the spool contour.

It was the object of the original design that by adopting this varied means of blade retention it should be possible to replace blades without stripping down the engine. Removal of the top half of the compressor casing gives access to the first and second stages of rotor blades because the shrouds give axial clearance for blade removal. Blades in the third to the 10th stages are easily removable from the circumferential dovetail.

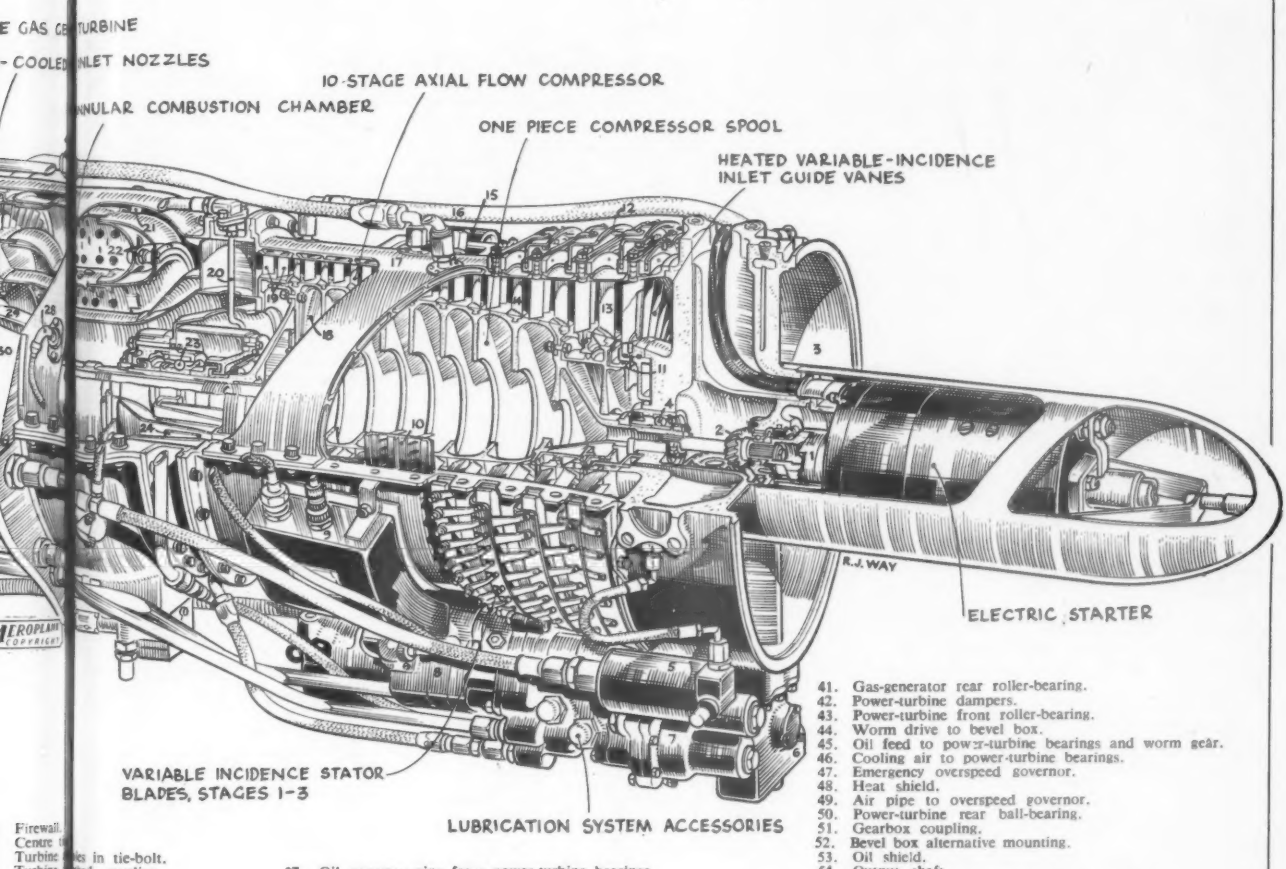
It has been found practicable in the U.S.A. to replace blading in three stages without removing an installed engine. This was done by distributing the replacement blades circumferentially by weight, according to the weight distribution of the original blades. No vibration was experienced after blade replacement in this manner.

Compressor casing (Rex 448) and stator rings (S.61) are split on the horizontal line and the stator-blade rings are carried by T-section slots. Each stator ring carries two stages of fixed stator blades, the final ring carrying stage 10 of stator blades and the exit guide vanes.

The fixed stator blades are attached to the rings by brazing. Inlet guide vanes and the first stage of variable stator blades are

e Havilland Gnome D.Ge.1

,000-s.h.p. Shaft Turbine



Firewall.
Centre ti
Turbine les in tie-bolt.
Turbine ed coupling.
Bearing
Air bleed
Flexible -turbine governor.

37. Oil scavenge pipe from power-turbine bearings.
38. Bevel box.
39. Thermocouple.
40. Stage-two turbine honeycomb seal, and cooling plate.

41. Gas-generator rear roller-bearing.
42. Power-turbine dampers.
43. Power-turbine front roller-bearing.
44. Worm drive to bevel box.
45. Oil feed to power-turbine bearings and worm gear.
46. Cooling air to power-turbine bearings.
47. Emergency overspeed governor.
48. Heat shield.
49. Air pipe to overspeed governor.
50. Power-turbine rear ball-bearing.
51. Gearbox coupling.
52. Bevel box alternative mounting.
53. Oil shield.
54. Output shaft.
55. Oil scavenge pipe from reduction-gear pump.
56. Oil supply pipe to reduction-gear pump.
57. Reduction-gear oil pump.

supported by the shrouds on the inner diameter. Second and third stages of the blades are cantilevered from the outer diameter.

As the four rows of variable-incidence inlet guide vanes and stator blades all move through the same angle, their actuation can be " ganged " together. Four actuating rings are supported in the grooves of other rings which also carry vane bearings. The actuating ring for the third stage is carried on the ring which has the bearings for the second stage of vanes, and the second stage actuating ring is carried on the ring with the first-stage vane bearings. The ring with the bearings for the inlet guide vanes carries two actuating rings, that for the first stage stators on the rear side and the actuating ring for the inlet guide vanes on the forward side.

By isolating the actuating rings from direct contact with the compressor casing, thermal effects on accuracy of the vane and blade settings are minimized. This system also allows the use of relatively long lever arms from the rings to the vanes, which has the advantage of further reducing any setting inaccuracies.

Hot air is bled from the rear of the compressor and taken forward for thermal anti-icing of the intake duct struts and the inlet guide vanes.

The annular combustion chamber has a one-piece Nimonic 75 flame tube. A flow-splitter ring fits into the throat of the diffuser and extends axially until it meets the flame tube. This ring ensures that there is a correct distribution of flow over the inner and outer surfaces of the combustion chamber. The combustion chamber outer casing is in Rex 448.

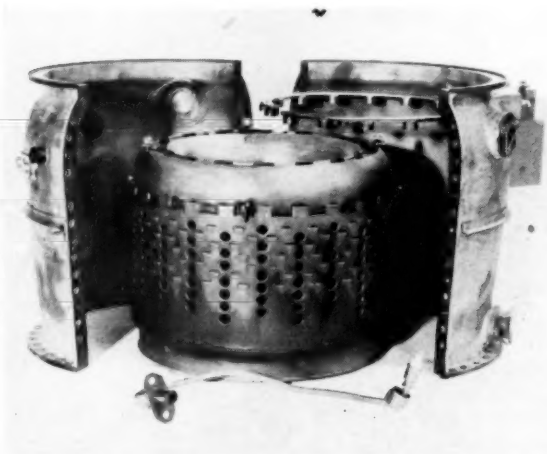
There are 16 fuel-injector nozzles carried on two ring manifolds, eight on each manifold. For starting up and at low rates of fuel flow only half the nozzles are supplied with fuel. Beyond a chosen point, a flow divider opens and feeds the other eight nozzles with fuel.

Rotor parts of the two-stage gas generator turbine are stacked on toothed face-couplings and held together by a central tie-bolt. The third bearing of the gas-generator rotor shaft is outrigged from the second-stage turbine to give good support for the shaft. As the turbine stages are stacked there is no need for horizontal flanges on the turbine casing because of increased durability and stability of the assembly, thus permitting close control of the diaphragm area which is important for consistently high performance.

Turbine blades are of forged Nimonic 90 and are attached by dovetail fastenings to the Rex 448 wheels. Each blade has an extended root which isolates the wheel rim and retaining dovetail from the hot gases. Turbine shrouding, in Nimonic 75, is in segmental sections to allow thermal expansion without increasing turbine blade tip-clearance.

Nozzle diaphragms are brazed up and have Stellite stator blades. The Nimonic 75 inter-turbine seal is of honeycomb type; this represents no new departure for de Havillands because seals of this type have been in use for some time in their engines.

Completely independent mechanically from, but gas-linked



COMBUSTION CHAMBER.—The flame tube of the annular combustion chamber of the Gnome is supplied with fuel from 16 nozzles mounted on two ring manifolds.

to, the gas generator is the free power turbine which has a Rex 448 integral wheel and shaft, and forged Nimonic 80A blades. Power turbine blades have light sheet metal dampers to change the resonance frequency which caused some trouble with blade failures on early T58 engines.

An exhaust-duct casing fabricated in Nimonic 75 sheet turns the efflux through 60°, allowing access to the rear of the power turbine shaft and the rear mounting point of the engine. The power turbine assembly is arranged so that the exhaust may be directed downward, to the right or to the left according to aircraft installation requirements.

When a reduction gear is required, an offset gear of 3.25 : 1 ratio is fitted and weighs 75 lb. complete with integral oil supply and scavenge pumps. Further speed reduction is to be made at the rotor head for a helicopter. For a turboprop application the gear ratio would be increased further.

Lubrication, electrical and fuel systems do not call for special comment, but the control system is worth noting. It is designed to take full advantage of the free power turbine so as to provide a constant-speed rotor for maximum efficiency of a helicopter.

The control unit maintains a selected power turbine speed; prevents gas generator and power turbine overspeeding; prevents compressor stall, over-heating of the turbine and rich or lean mixture flame-out; governs idling speed of the gas generator; schedules inlet guide vane and stator blade settings to give optimum efficiency; provides protection from excessive pressures, and meters fuel for distribution to the combustion chamber.

The single-lever speed-control has a 120° range of movement. From 0° to 3° the engine is shut off; at 50° engine idling speed is reached; from 50° to 70° the engine is brought from idling up to the free power turbine governing range; at lever position between 70° and 120° the engine-control system automatically regulates fuel flow to maintain the output shaft at the selected speed.

The range of rotor speed control is 15%, rotor r.p.m. being maintained as selected within the operating limits of the engine. At full power the gas generator runs at 26,300 r.p.m. with a corresponding free power turbine speed of 19,500 r.p.m.

By June of this year the T58 had run for 6,750 hr. on test-beds and a further 1,750 hr. in helicopters or on rotor rigs. The engine has been installed and flown in coupled form in Sikorsky S-58 and Vertol H-21D helicopters. It has been chosen as the powerplant for the twin-engined Sikorsky S-61 and the single-engined S-62 and Kaman HU2K-1. There are several possible applications in STOL designs.

Although the T58 has passed its American type-test, the D.H. Gnome will be put through the British type-test. The Gnome would most logically be first installed in a Westland Whirlwind helicopter for test flying because this aircraft would be a suitably available vehicle. The engine would have to be de-rated for this because of the limits imposed by the capacity of the helicopter's transmission.

Service use in helicopters for production Gnomes is a strong probability, and a number of companies are interested in the turboprop version for executive transports and STOL aircraft. De Havillands are confident that they are building the right engine for the market. The elegant mechanical design presents no new problems of either manufacturing methods or cost of production. The rewards of using such a design are evident in the very low weight and very high power/weight ratio achieved for an engine only 5 ft. long and 1 ft. 6 in. wide.

At present the Gnome is a 1,000-s.h.p. engine, but this figure will be raised to 1,250 s.h.p. in the normal course of development; and there is no reason why 1,500 s.h.p. should not be eventually attainable. The engine has been completely re-worked for British materials and accessories so that there will be no dollar difficulties in production or for operators requiring spares. Those accessories made by General Electric for the T58 are being made by de Havillands for the Gnome.

The race for the 1,000-s.h.p. prize is on and the D.H. Gnome is well fancied in view of its breeding and past record. There is every chance that it may prove to be a popular workhorse on this side of the Atlantic, too.—D.G.

The New Crusader

MAJOR modifications have been made to the Chance Vought Crusader supersonic interceptor for the U.S. Navy. In its latest form, as the F8U-3, the Crusader has a new type of air intake, a pair of folding ventral fins and uses blown flaps.

The air intake is a modified version of the Ferri-designed intakes used on the Republic F-105 Thunderchief and proposed for the Chance Vought F9U-1 Super Crusader (THE AEROPLANE, March 14). Whereas these applications of the Ferri intake were at the wing roots, the F8U-3 Crusader retains its "chin" intake, but has the characteristic Ferri swept-forward lip containing a movable wedge to vary shock-wave angle with flight speed to suit the engine requirements.

The Mach 2 generation of American fighters have all had their troubles with directional stability at high speeds. The Lockheed F-104A Starfighter grew a ventral strake and the Chance Vought F8U-2 recently appeared with two such strakes (THE AEROPLANE, April 11, pages 498 and 522).

The newest Crusader evidently needed more stability to match its increased speed and this has resulted in the fairly drastic step of adding two large ventral fins, so large that they have to be folded up horizontally before the aeroplane can land—giving the Crusader a heavily staggered biplane tail at low speeds.

Other alterations include fitment of a Pratt & Whitney J75 turbojet of 17,500 lb. thrust (26,000 lb. with afterburning) instead of a J57. It was reported earlier that a Reaction Motors Inc. liquid-propellent rocket would be fitted to the F8U-3, but there seems now to be no evidence of this.

Air bled from the engine compressor is blown over the trailing edge flaps of the F8U-3 to improve the performance of the variable-incidence wing at take-off and landing. The cockpit canopy is now more "submerged" in the fuselage lines and the fuselage nose is longer, more pointed and canted up—presumably to suit the new air intake.

First flight of the F8U-3 was on June 2 and lasted 38 minutes, with John Konrad at the controls. An advanced automatic flight system and missile system are fitted. By pressing a "Mach hold" button, the pilot obtains a climb to height at a chosen speed and angle. For cruising, he selects "altitude hold," another button-pressing holds the aircraft's heading and to change heading the pilot dials a "heading select indicator." There are special limiting devices to restrict pulling excessive *g* and a "roll-rate limiter" prevents deviations from manœuvres leading to loss of control.

The F8U-3 is armed with Sparrow 3 missiles, infra-red Sidewinders or both. Span and length are 39 ft. 11.4 in. and 48 ft. 8.8 in. respectively.

Impressions of the Structural Design of American Civil Aircraft

by A. F. Newell, M.I.Mech.E., A.F.R.Ae.S.*

AS the result of a visit made to the U.S.A. in the fall of last year, it is proposed to review some of the structural design concepts of the Boeing 707, Douglas DC-8 and the Lockheed Electra, and see how they have been interpreted in detail.

Each of the manufacturing firms has an excellent reputation in the design and construction of large civil and transport aeroplanes; even so, it is of great interest to see that although the principles of design are the same, the detail execution is vastly different.

It is obvious that in designing costly transport aircraft new levels of safety, reliability and endurance must be provided in parallel with the increase in speeds. A point which cannot be over emphasized is the large number of passengers that can be carried in the high-density versions of these aircraft.

Although seating arrangements must be flexible, the maximum number of passengers claimed for the 707 and DC-8 is 150 and 171 respectively; the Electra carries 85. With such payloads a catastrophic structural failure is inexcusable.

Aircraft designers throughout the World have accepted—or had forced on them — this responsibility, and have formulated a basic structural design philosophy as follows:—

(1) High level of safety, which incorporates

(a) high residual strength of the structure after some damage has occurred;

(b) slow rate of crack propagation.

(2) Ease of Maintenance and Inspection

It naturally follows that if some form of crack can develop in a structure, then in those areas where there are major fittings and joints, ready access for inspection must be provided. A universal trend is the acceptance of the distributed as against the concentrated load wing spars, where it is hoped that visual inspection will readily determine damage.

(3) Long Life

Costly aeroplanes must be expected to have high rate of utilization and considerable " stretch " in the design to meet future operating capabilities. As the pure-jet aircraft are designed to operate at high subsonic speeds, the next significant step in air transportation will be supersonic. The present economic factors, in both the U.S.A. and U.K., suggest that this step will not be taken for some considerable time.

(4) Minimum Structure Weight

The main problem here is to be able to assess accurately the loads and strength requirements for which the aeroplane is designed. The choice of materials, the assessment of stress levels and the environments of installations is the art of design, but it remains an art and hence a potential weight penalty, unless the load requirements are determined correctly.

Boeing 707

Structural Design

Boeings have an advantage here in so far that the 707 is a follow-on of the KC-135 military tanker aircraft. The wings are similar in many respects, and consequently all the full-scale testing has been fed back into the design of the 707. Also in both the B-47 and B-52 programmes extensive flight-load surveys were conducted to check the analytical methods from which the aeroplanes were designed, data which would be invaluable to any competitor adopting a similar wing configuration.

Wing

In detail the 707 wing consists of a centre section the width of the fuselage, and the port and starboard mainplanes are swept back 35° and bolted to the centre section. A typical cross-section of the wing giving the principles of construction is shown in Fig. 1. A considerable volume of the wing is an integral fuel tank.

The bending strength of the wing is provided by several separate pieces of skin approximately 28 in. wide and extruded stringers. On the wing lower surface the stringers are approximately 7-in. centres.

The wing is so designed that complete fracture of any one skin panel can be sustained, and the residual strength of the wing will be maintained at levels greater than required by the C.A.A. fail-safe criteria. At each skin splice a structural member heavy enough to stop a crack is provided.

The maximum skin thickness is ½ in. and the design criteria is strength not stiffness. Use is made of 78 ST materials for the upper surface skin and stringers compression material. The maximum stress in the compression panels is 66,000 p.s.i. and occurs at 0.3 semi-span.

The lower surface skin material is 24 ST, to which stringers of 75 ST are attached. The reason for having materials to three different specifications on the wing structure is because 24 ST has better crack-retarding properties than either 75 ST or 78 ST alloys, in so far that it possesses a greater critical crack length, and has a slower rate of crack propagation than the stronger 75 and 78 ST alloys, hence the reason for its use on the tension skin.

In the *1g* case the normal tension stress on the lower surface is 14,000 p.s.i. On the upper surface 78 ST is used because of its high compressive strength.

The stringers are riveted to the skins by A.17 rivets, the countersunk heads are formed last in the outer surfaces of the skin.

At the wing-body junction, the attachments are on the neutral axis of the spars, to minimize " pinching " of the frames when the wing flexes. The wing carries the pressurization loads over the centre section.

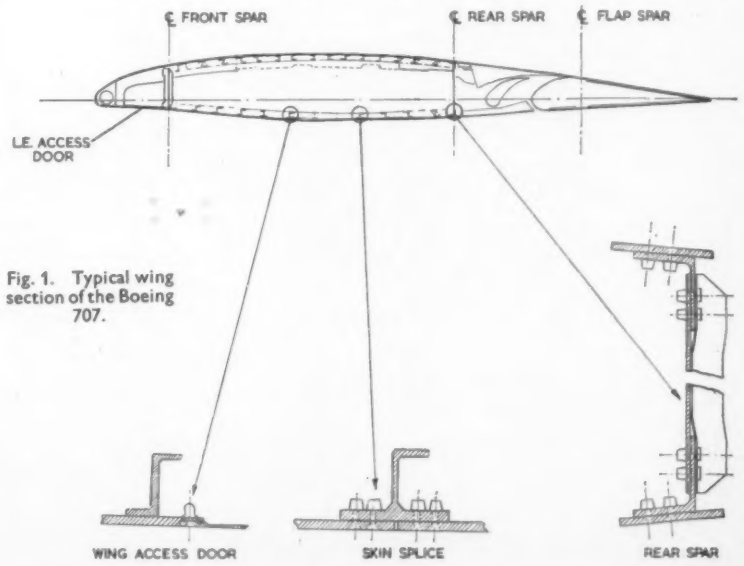


Fig. 1. Typical wing section of the Boeing 707.

Douglas DC-8

As distinct from the Boeing 707, Douglas has designed the DC-8 as a commercial aircraft without drawing from the experience of a parallel military programme. Granted many of the features of the DC-6 and DC-7 series have been incorporated in the DC-8, but it must be considered remarkable that Douglas had received orders to a total value of more than $600 million for an aeroplane that had yet to be flown.

It is reported that Douglas has spent $19 million during 1956 in experimental and development work on the DC-8, and it is thought that total costs under these headings will ultimately reach $30 million. It is not surprising therefore that, because the basic approach to the design of similar aeroplanes by Boeing

* Deputy Head of the Department of Aircraft Design, College of Aeronautics, Cranfield.

Boeing's Model 707 has a two-spar wing in two main units and a double-bubble fuselage.

and Douglas is different, the detail design has very little in common.

Wing

A plan view of the wing structure of the DC-8 is shown in Fig. 2. The wing is three-spar construction with sculptured T-section booms and heavy sheet webs having vertical stiffeners.

Wing skins, upper and lower, are 75 ST AL and are roll-tapered in thickness in the spanwise direction, maximum thickness being approximately ¼ in. Inboard skins are joined at the centre of the aircraft and extend to the region of the outboard pylon, being stretch-formed to contour at the sweep break. One skin extends chordwise from the front spar to centre spar, and another from the centre spar to rear spar on both top and bottom surfaces. Outboard skins are also roll tapered.

Wing stringers are 75 ST.6 extrusions. Upper stringers are Y-section spaced 7.2 in. apart, and lower surface has I-section stringers at 5.5-in. pitch. The maximum ultimate tensile stress is approximately 50,000 p.s.i. and at *1g* the stress level is approximately 11,000 p.s.i. both stresses computed on gross area.

Fig. 3a shows a typical upper stringer to rib joint. The offset flanges on the stringers are to suit the standard forged stringer-rib cleats. Fig. 3b illustrates the lower stringer-rib joint. Here again the I-section stringer has an offset flange.

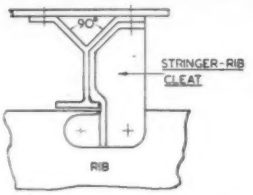


Fig. 3A.—Top stringer-rib attachment.

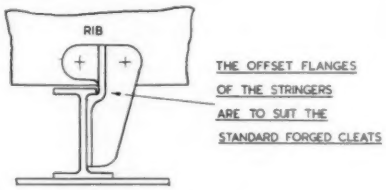


Fig. 3B.—Bottom stringer-rib attachment.

As can be seen from Fig. 2, the wing is one vast integral fuel tank, and the access panels shown can be used for inspecting structural damage to spars. With this type of wing construction, the amount of structure assumed failed is somewhat hard to define. The Civil Air Regulations call for "failure or obvious partial failure of a single principal structural element."

Douglas considers a principal structural element of the wing to be a spar cap, spar web, stringer and associated skin, fitting or bolt, or a control surface hinge bracket. In addition to the fail-safe philosophy, all major structure has been tested to develop fatigue resistant designs.

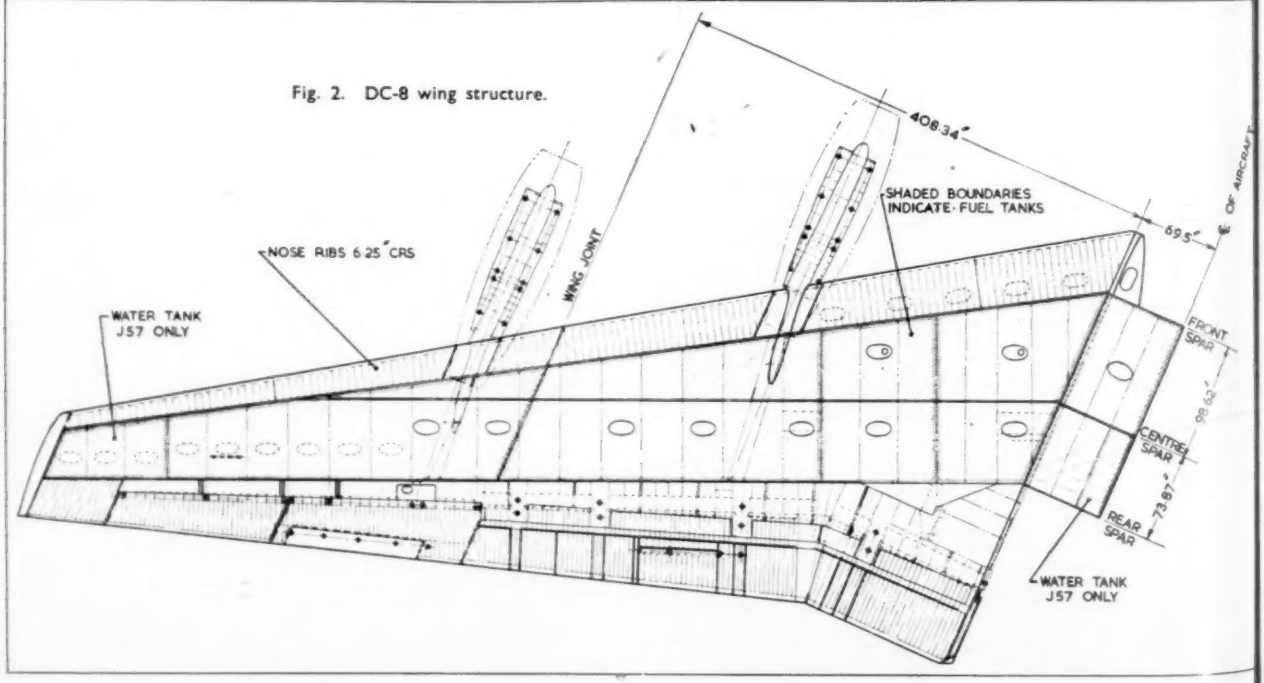
Lockheed Electra

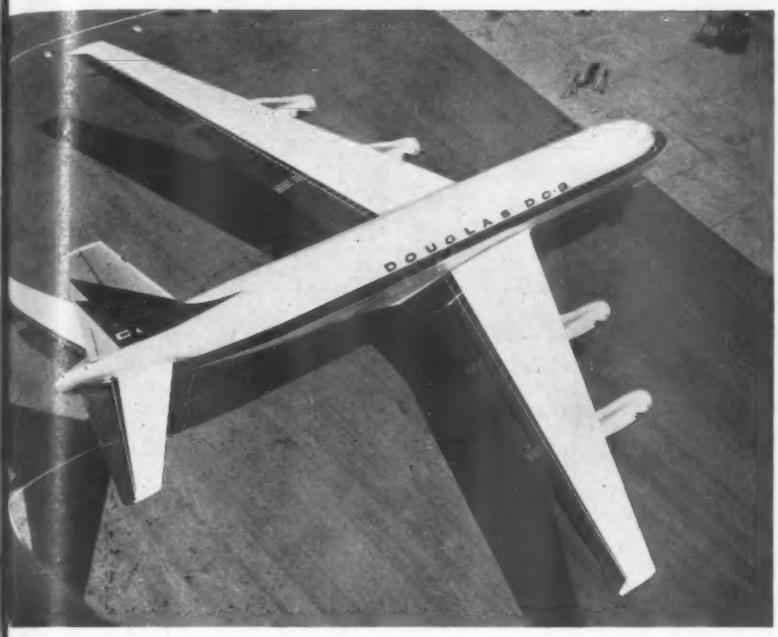
Although the Electra is in a category different from the previous two types, being a short- and medium-range turbo-prop aircraft against the long-range turbo-jet, it is, nevertheless, interesting from a structural standpoint.

Wing

The wing has no sweepback and consists of a box spar, having two webs. The upper and lower surfaces are built up from integrally stiffened machined panels.

Fig. 2. DC-8 wing structure.





The three-spar wing of the Douglas DC-8 spans 139 ft. 8 in. and is assembled in one piece.

The panels are 7178 alloy on the upper surface, but most of the remainder of the wing is 7075 alloy. A diagrammatic cross-section of the wing is shown in Fig. 4.

As is well known, integral stiffeners do not act as good crack stoppers. Why then should Lockheed use a material like 7075 alloy in the lower skin? The reason for this is given by Mr. E. H. Spaulding, chief structures engineer, in S.A.E. paper No. 92. The critical wing tension stresses are low enough to use 2024-T3 material, more material, hence weight, would have to be added to support these high down-bending taxi-ing loads because of the lower compressive strength of 2024-T3. The maximum wing lower surface gross area tension stress has been stated to be 50,000 p.s.i.

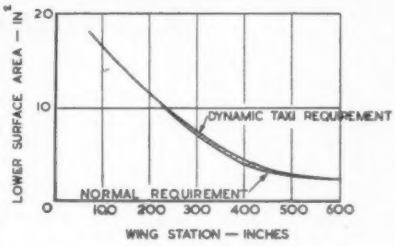


Fig. 5. Additional strength points.

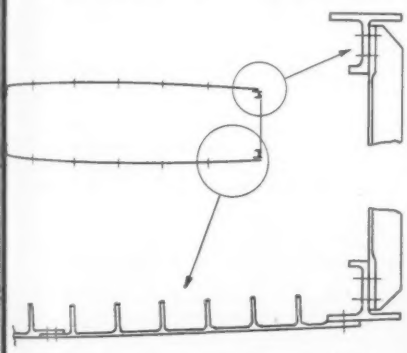


Fig. 4. Panels about 20-in. machined extrusions.

design condition is produced by taxi-ing with full fuel for take-off. A flexible wing receives random load impulses due to the unevenness of runways, and the response or "bounce" increases the down bending load.

Fig. 5 illustrates the portion of the Electra wing where additional strength was added to resist the dynamic taxi-ing down bending moments. It is this case that has dictated the use of 7075-T6 in wing lower surfaces. Although the design

The fail-safe approach on the wing tension skin is the assumption that if one panel fractures, its load is transferred to adjacent panels, which pick up the load and carry it around the break and back again. The spanwise joint must be able to perform this load transfer anywhere in addition to doing their normal job of shear transfer. This requires that greater joint strength be present in all spanwise joints.

The spanwise panels (machined extrusions) are joined by steel attachments. In the event of a panel fracture, bearing on the steel pins becomes critical and allows plastic deformation, thus spreading the load to be transferred over a larger number of attachments, and reducing the load to be taken by each.

Lockheed claim that the separate panel-type of construction is advantageous when the use of a high-strength alloy is dictated by compression requirements. High-strength alloys such as 7075-T6 are less resistant to crack propagation than the lower strength 2024-T3 types. Cracks that may develop within a panel are arrested at spanwise joints, thus allowing time for their discovery.

Machined panel construction as distinct from rolled taper sheets, has an advantage in that it permits the use of raised pads to minimize points of stress concentration and to provide integral reinforcement around discontinuities. The number of rivet holes required are greatly reduced, this minimizing the possible sources of fatigue.

The remaining point of interest on the Electra wing is the wing shear web and spar booms. The conventional two-spar box is not the best construction for supplying alternate load paths for torsion in the case of a failure of the shear web. Lockheed has overcome this in the following way:—

(1) The web is machined from thick plate with extra thickness of the web at

With a semi-monocoque circular-section fuselage and two-spar box-beam wing, the Lockheed Electra has a loaded weight of 113,000 lb., with a possible increase to 116,000 lb.

the attachment to the spar caps. Steel attachments join the web to the spar cap, and are equally critical in bearing on both web and cap.

(2) The thickened web is so sized that it can take sudden additional load should a spar cap fail.

(3) If the shear web should be first to fail and crack the full depth of the web, the spar caps are shaped to carry the fail-safe shear loads by differential bending between the integrally machined stiffeners on the machined web. A design such as this should give a good fuel-tight tank.

(to be concluded)

This data is of necessity brief and incomplete, but its purpose is to show how the interpretation of fail-safe design can be so varied.

SUMMARY OF WING CONSTRUCTION

	No. of spars	Type of skins	Type of stringers
Boeing 707	2	Planked taper 78 ST upper 24 ST lower	Extruded Z riveted 78 ST upper 75 ST lower
Douglas DC-8	3	Large taper rolled sheets 75 ST AL 6 upper 75 ST AL 6 lower	Extruded riveted Y section 75 ST. 6 upper I section 75 ST. 6 lower
Lockheed Electra	2	Machined extrusions 78. T6 upper 75. T6 lower	Integral stiffeners

Where Do We Go From Here?

ASKED by Mr. Leavey in the House on July 30 what progress has been made in discussions with the M.T.C.A. regarding the provision of facilities for private and commercial flying at Biggin Hill when Croydon is closed, the Air Minister, Mr. Ward, replied that the best was being done to work out arrangements which will allow an approach to the civil firms and clubs affected, "but it is not at present possible to announce a detailed scheme."

As Croydon is to be closed in October, many people feel that an announcement regarding arrangements for the organizations which will be affected is already much overdue. Where are the various clubs and maintenance companies to go? Some of the latter, we understand, hope to remain at Croydon, although no flying will be possible.

In a further reply Mr. Ward stated that "we are very keen to help these people," but there were "some practical difficulties."

The difficulties have been understood for some years, ever since the question of closing Croydon first arose. We still do not know what form the "help" is going to take.

More About The Tu-114D

OUR contemporary, *Skrzydlata Polska*, of July 23, states that early in July two Tupolev Tu-114Ds went through a series of high-speed cruise tests over various distances. On one 9,600-km. trip, from Moscow to Lake Baikal, the average speed achieved was 740 k.p.h.

The second aircraft, carrying 24 people, made an extensive tour of the U.S.S.R. It covered 34,400 km., with landings at Vladivostok, Tashkent and Minsk, in 48 hr. 30 min. flying time. Average speed was 710 k.p.h. at heights between 10,000 to 12,000 m.

The route was as follows: (a) Moscow-Dickson Island-Tiksi-Cape Taigonos-Chabarovsk-Vladivostok (9,000 km.); (b) Vladivostok-Komsomolsk-Petropavlosk-Tashkent (8,753 km.); (c) Tashkent-Stalinabad-Frunze-Alma Ata-Omsk-Dickson Island-Archangelsk-Minsk (8,050 km.); (d) Minsk-Leningrad-Tallin-Riga - Vilnius - Kiev - Kishinev - Tbilisi - Erivan - Baku - Ashkhabad-Rostov-Moscow (8,597 km.).

The aircraft thus flew over all the capitals of the Union's Republics. One of the objects of this flight was to test the aircraft's behaviour in all weathers and temperatures. The Tu-114D flew through several storms but behaved perfectly and engines and electronic equipment worked without a hitch.

Tu-114s are said to be going into regular service with Aeroflot.

Avro Magnetohydrodynamics

INTERESTING trends in research by A. V. Roe and Co., Ltd., are revealed by a recent company advertisement for physicists and mathematicians. They are needed by the Avro weapons research division for work on magnetohydrodynamics.

The term magnetohydrodynamics appears to have originated in the United States; it can be defined as the study of the interaction between magnetic fields and electrically conducting fluids and gases. As such magnetohydrodynamics—or MHD for short—is very much concerned with controlled thermonuclear fusion studies.

One of the aims of MHD studies in the U.S. is the production of a fusion powerplant for propulsion of space vehicles. In theory the specific impulse of such fusion engines could approach 2-3 million seconds, but only at a very low thrust. Thrust could be increased by the injection of gases, but at the cost of lowering specific impulse to perhaps 3-4,000 seconds.

Other likely fields for MHD work are boundary-control for aircraft travelling at speeds high enough for airflow over them to be partially ionized, the study of radio communication with space vehicles travelling at high speed and surrounded by ionized gas, and the provision of electrical drag for the re-entry of satellite vehicles.

An American report suggests that MHD studies could lead to methods for disarming or destroying nuclear weapons in flight by radiation. Other MHD investigations may have an important bearing on theories about the origin of the solar system, the causes of weather disturbances and the production of cosmic rays.

Mr. Shute's Latest

AMONG the novels of Nevil Shute there are some remarkably fine stories and some fascinating forecasts. Who, after reading "No Highway" and pondering on subsequent events in the real world of aviation would not be moved to wonder whether the author's uncanny foresight might not be equally reliable in his later "In the Wet" and "On the Beach"?

One of the things that makes Nevil Shute so readable is that not only are the events in his books interesting in themselves but they also have a verisimilitude that springs from his meticulous care to get the details into proper focus. Where lesser writers leave one with vague impressions, he gives his readers facts—and always facts in a form that help to make his characters and events come to life.

In his latest book, "The Rainbow and the Rose,"* Nevil Shute is at his storytelling best. As always, the authentic aeronautical background he provides makes good reading for anyone having connections with aviation and particularly those who have been in the business for any length of time.

This is a simple story of the life and loves of John Pascoe, a 60-year-old airline pilot; and his story is told—most ingeniously—by another airline pilot, one of Pascoe's former flying pupils.

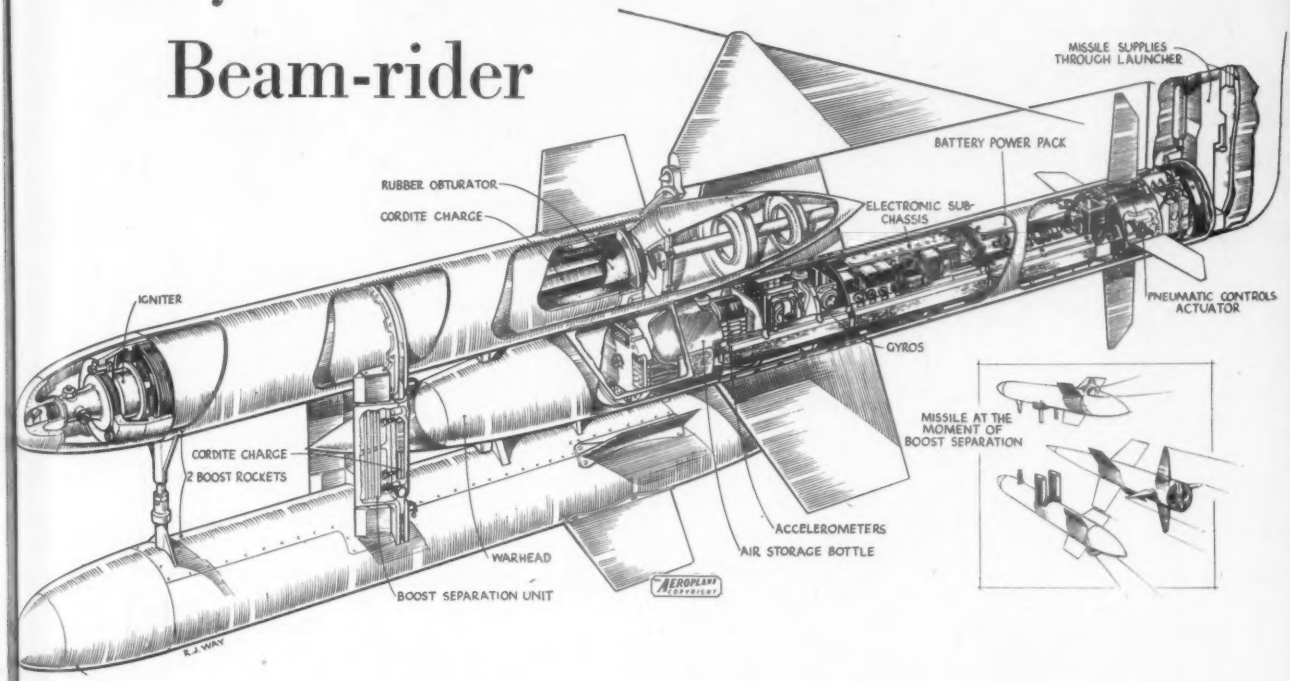
"The Rainbow and the Rose" is really a trilogy, for it covers Pascoe's experiences in World War One, his flying club life between the Wars and his work as a senior airline pilot. In each Nevil Shute has taken great pains to produce the right sort of atmosphere. His contemporary description of a loop in a rotary-engined Camel, for example, must have caused him infinite trouble to seek out:—

> "These rotary engines . . . the Le Rhônes, the Monos and the Clergêts! They made a sort of crackling hiss, and always the same smell of castor oil spraying backwards down the fuselage in a fine mist over your leather helmet and your coat. They were delightful to fly, the controls so light, the engines so smooth-running. Up among the sunlit cumulus under the blue sky I could loop and roll and spin my Camel with the pressure of two fingers on the stick beside the button switch which I used as little as possible.
>
> "Looping, turn off the petrol by the big plug cock upon the panel just before the bottom of the dive, ease the stick gently back and over you go. The engine dies at the top of the loop; ease the stick fully back and turn the petrol on again as the ground appears so that the engine comes to life five or six seconds later. . . ."

It is this sort of reality that makes "The Rainbow and the Rose" an excellent book and Nevil Shute a first-class novelist.—F.T.M.

*"The Rainbow and the Rose," by Nevil Shute. Published by William Heinemann. Price 16s.

Fairey's Air-to-Air Beam-rider



MORE than a year has elapsed since Fireflash completed satisfactorily its comprehensive Ministry of Supply acceptance trials. It was the first British guided weapon to do so. Its accuracy, lethality and reliability are proven—not by scientists' experiments conducted in a feather-bed environment but by arduous trials conducted jointly by the R.A.F. and M.o.S.

R.A.F. personnel co-operated to the full in the weapon acceptance trials, and have since been engaged in the Guided Weapon Development Squadron trials of Fireflash, in which the organizational and tactical problems of service utilization of air-to-air guided weapons are being worked out.

A squadron of Swift Mk. 7 aircraft is being used for this purpose, flown from Valley, Anglesey, firing trials being carried out over the Aberporth range. The success rates achieved in airfirings of Fireflash weapons under these operational conditions are no worse than, and are sometimes even slightly better than, those obtained in the initial weapon acceptance trials.

The complete Fireflash missile comprises a central "dart," which contains the warhead, fuse, power supplies and guidance and control equipment, and two external solid propellent boost rockets which accelerate it to maximum speed.

The missile is supported on its aircraft launcher by a rear ball fitting engaging in a corresponding hemispherical socket in the missile rear bulkhead, and by an explosive bolt which forms the front support engaging in a lug on the upper boost rocket. Forward movement of the missile on the launcher due to fighter accelerations during manœuvre is restrained by a retractable pin through a diameter of the rear ball fitting.

Jettison of the missile from the aircraft, when necessary, is achieved by firing the forward explosive bolt, when the missile rotates downwards about its rear end and falls away after disengagement. The normal rocket firing circuit cannot be completed until the rear restraining pin is withdrawn.

The boost motors are 5-in. diameter, steel-cased cordite motors, fired by igniters screwed into their forward end-caps. The tubes are surrounded by a 0.5-in. layer of lagging to reduce the temperature variation of the cordite charge during external air-carriage, and, in particular, to ensure that the charge does not crack from excessive cold at great heights.

The boost venturis are offset at an angle of 20° in the vertical plane, the aim being to direct the component of the rocket thrusts in the vertical plane approximately through the centre of gravity of the motored missile. This condition is not achieved exactly, for some variation of centre of gravity position occurs as the charge burns, but any yawing moments imposed on the missile due to statistical variations in thrust from rocket to rocket are thereby minimized.

Similarly, a stabilizing clockwise spin is induced in the missile during the boost phase by offsetting the boost venturis anti-symmetrically in the horizontal plane. This angling of the venturis also directs the exhaust cone away from the tips of the missile rudders and prevents damage during motor burning.

The forward end of each boost assembly houses inside an ogival fairing a pressure switch. The boosts are also fitted with a cruciform arrangement of rear stabilizing fins.

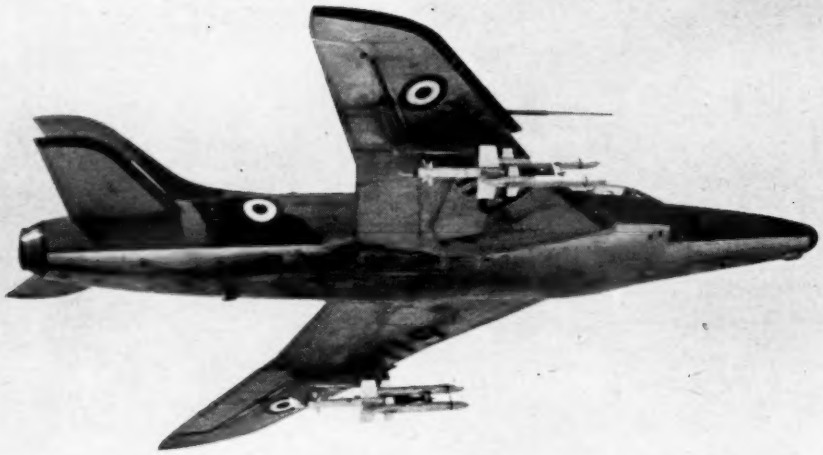
The two boost motors are held together by a central separation unit which straddles the nose of the dart. The only attachment of the boosts to the dart is by two saddles on the lower boost and a single saddle on the upper boost each of which react against the warhead surface, thrust being transmitted by spigots engaging in holes in the warhead. The boost noses are held apart by an adjustable spreader bolt which pivots the boosts around the separation link pins nutcrackerwise to preload the boost assembly to make it rigid.

The separation unit consists of a double piston-cylinder unit containing fast-burning cordite and an electrical igniter. The pistons, attached to one boost motor, are retained by shear pins in the cylinders, attached to the other boost motor. The pressure switches in each boost nose are connected in series in the separation firing circuit. Each is armed by the build-up of pressure in its rocket tube on ignition and it completes the circuit when the rocket pressure subsequently falls to a predetermined level.

The separation unit, therefore, cannot operate until both motors have fired and until the thrust of each has practically ceased. A firing pulse then passes to the separation unit igniter, the pressure builds up sufficiently to fracture the shear pins and the pistons leave the cylinders as from a gun.

The expended boosts accelerate away from each other and disengage from the dart without disturbing its flight. Separation is complete in 7 milliseconds, the lateral velocity of each boost relative to the dart being about 60 ft./sec.

It is possible to build up and store the explosive assembly comprising warhead, fuse, two boosts, and separation unit independent of the rest of the missile. All control and guidance equipment is located aft of the warhead and it is thus possible to carry out all pre-flight checks of this equipment, in perfect



Fireflashes have been launched from specially modified Supermarine Swift FR. 7s. The revised nose shape of the Swift is necessary because of the radar equipment needed for the beam-riding missiles.

safety, before the missile is armed with its explosive components. This facility is invaluable in operational use.

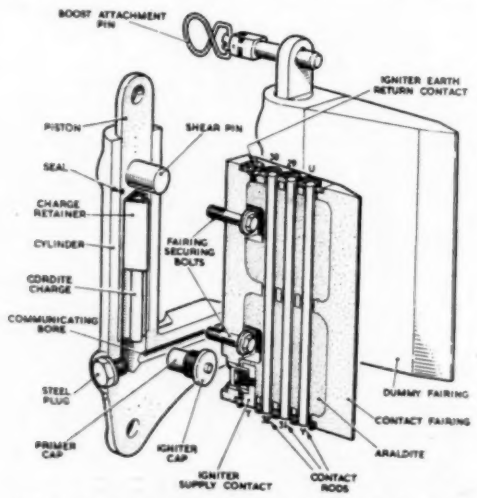
The main structure of the dart consists of the following sub-assemblies: the proximity fuse, the warhead, the airframe, and the internal components chassis.

The fuse forms the nose section of the dart, has a fibreglass aerial window, and has a rear fitting which attaches to the front end of the warhead, engaging an internally threaded rack-toothed ring. This ring is restrained from fore-and-aft movement by a locating plate but can be rotated by a small pinion which engages with teeth on the rear face of the ring. When the pinion is rotated by an externally applied brace and the fuse is inserted in the front of the warhead, the two are drawn together. A key on the fuse engages a keyway in the warhead to attain correct radial location and consequent alignment of electrical plugs and sockets.

A similar device, permitting a screwed joint between two adjacent parts without relative rotation of them during assembly, attaches the rear end of the warhead to the body.

This is the main structural member of the missile and is fabricated from a magnesium-zirconium alloy extruded tube upset at the forward end and forged to provide flats in way of the wing attachments. The bore of the body tube accommodates the internal component chassis which is inserted from the rear end and has a rear bulkhead which closes the end of the body.

The wings, four in number and spaced 90° apart, are attached by screws through their root flanges to the body tube. These wings are solid light alloy forged to shape and finished size, the only machining necessary being the mating surface of the root flange. The rudders, the control surfaces, are similar coined-forgings, and pass through apertures in the rear of the body tube



When the booster rockets are exhausted they are jettisoned by the action of this boost-separation unit. The missile then coasts on to its target.

to engage the actuator spindles to which the roots are dowelled and secured by ring nuts.

The internal components chassis supports components, from front to rear, in the following order:—

(i) Pneumatic storage bottle which provides air for operation of the actuator. This is a forged light-alloy bottle closed by an end-cap. Mounted on the end-cap inside the bottle is a reducing valve providing a supply pressure at the required level, and outside the bottle an air-charging valve and an electro-pneumatic stop-cock.

(ii) Two accelerometers measuring missile lateral accelerations in the two control planes; each comprises a bob-weight on a torsion bar, the motion of which is damped by silicone fluid, with a potentiometer pick-off.

(iii) Gyro assembly comprising a roll displacement gyroscope and two yaw rate gyroscopes measuring in the two control planes. All gyros have air-blown rotors, and run continuously whilst the missile is being carried by its parent aircraft. After launch the gyros coast. The roll gyro provides a datum for roll stabilization and is uncaged at launch. It is mounted on the forward face of the gyro bulkhead. The two rate gyroscopes are mounted on the rear face of this bulkhead. Their rotors incorporate small permanent magnets which enable adequate compensation to be made for the falling rotor speed during coasting.

(iv) Electronic sub-chassis containing the guidance and control circuits, which is attached by anti-vibration mounts to the two end bulkheads. This carries the crystal unit, 14 guidance circuit blocks, and six control circuit blocks. All these blocks are resin moulded, circuit components being mounted upright in the resin between two insulated wafers, wiring within the block being printed on these wafers. The resin is contained in a metallic container to which are attached the sub-miniature valves associated with the circuits.

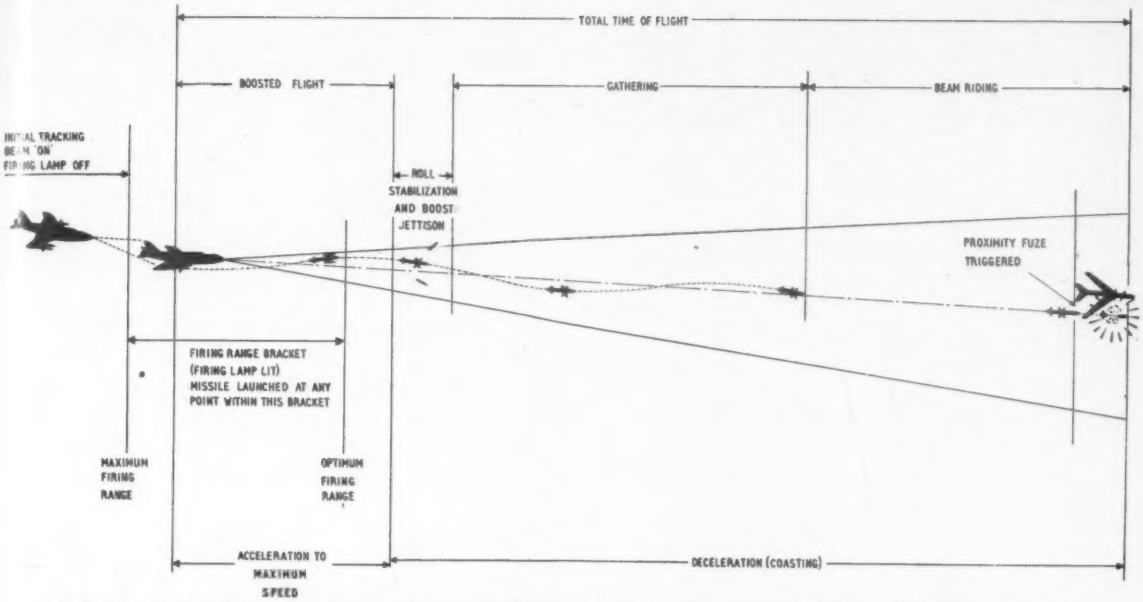
(v) The power pack. This is essentially a battery container comprising blocks of miniaturized rechargeable cells with two H.T. stabilizer circuits independently anti-vibration mounted on a tray. This provides H.T. and L.T. supplies to the missile and to the fuse.

(vi) The control servomotor which comprises:—
(a) The actuator assembly, a cylinder block with four pairs of bores, bolted to a housing which houses the bearings and drive shafts of the four rudders.
(b) A solenoid-operated release valve.
(c) Rudder locking mechanism which permits the control surfaces to be locked during air-carriage.
(d) Four electro-pneumatic relay valves which meter pneumatic system air to each pair of piston-cylinder units of the actuator controlling the four rudders.
(e) Four feedback potentiometers.
(f) Various switches.

(vii) The rear bulkhead which, in addition to providing the hemispherical seating for the launcher ball accommodates the aerial moulding, the hot air and gyro air entry ducts and the main aircraft-to-missile and test electrical sockets. The aerial is a polystyrene moulding flashed with silver on its external and internal surfaces. There is a co-axial feeder from the aerial unit to the crystal unit associated with the electronic sub-chassis.

The pneumatic storage bottle with its forward bulkhead forms the forward end of the chassis structure. Two hollow longerons extend backwards from it to the actuator. Electric looms and pneumatic pipe lines are routed along the longeron flanges, the central duct of each longeron being employed to supply hot air to the various components during air-carriage.

Aft of the actuator the chassis is completed by the rear


TOTAL TIME OF FLIGHT
BOOSTED FLIGHT
GATHERING
BEAM RIDING
INITIAL TRACKING BEAM 'ON' FIRING LAMP OFF
ROLL STABILIZATION AND BOOST JETTISON
PROXIMITY FUZE TRIGGERED
FIRING RANGE BRACKET (FIRING LAMP LIT) MISSILE LAUNCHED AT ANY POINT WITHIN THIS BRACKET
MAXIMUM FIRING RANGE
OPTIMUM FIRING RANGE
ACCELERATION TO MAXIMUM SPEED
DECELERATION (COASTING)

This diagram shows the method of attack by a Fireflash-armed interceptor. Having closed to within firing range, the aeroplane launches its missile which eventually beam-rides its path to the target.

bulkhead assembly. Intermediate bulkheads are provided with threaded adjusters which, by external manipulation, can be opened out after insertion of the chassis to provide additional support for the chassis and to prevent judder.

Guidance and Control System

An attack employing Fireflash is made at a range determined by a range-computer within the parent aircraft.

At their all-burnt stage the boosts separate radially from the dart, which then coasts towards the target. After separation the dart is quickly stabilized to a roll-datum predetermined relative to the wing-plane of the firing aircraft at launch. This enables the missile to establish its Cartesian axes precisely in space and to assess its position, relative to the attitude of the firing aircraft at launch. A roll reference gyro in the aircraft ensures that the guidance beam is lined up on the same axes.

After roll stabilization is complete the purpose of the guidance and control systems is accurately to steer the missile towards the target in response to information abstracted from the beam transmitted by an aerial system in the nose of the launching aircraft. The beam is harmonized with the gyro gunsight in the aircraft, the graticule of which is aimed visually at the target and must be held continuously on the target until strike occurs a few seconds later.

This is achieved by the pilot controlling his aircraft as in a normal gunnery attack, aim-wander during the attack being kept to a minimum by means of an autostabilizer in the rudder circuit of the aircraft. In large angle-off attacks, particularly against manœuvring targets, the required lead to the beam-axis is provided by the gunsight gyro facility.

The radar pulses are radiated in the form of a very narrow beam from an aerial in the nose of the aircraft, which produces a cone-like guidance beam of elliptical cross-section, the major axis of which is normal to the wing-plane of the firing aircraft at launch. When the missile is on the central axis of scan, its guidance receiver is provided with a signal of constant value. When the missile is off the axis, signals are provided for the guidance receiver to enable the missile control system to steer the missile back to the axis.

The data required from the radar beam are two polar co-ordinates: (i) The radial distance of the missile from the central axis; and (ii) the angular position of the missile within the scan, relative to a given reference datum.

The first co-ordinate is obtained as follows: When the missile is off the axis, the received signal, being dependent on the angular displacement from the central axis, as seen by the aircraft radar aerial, corresponds to the angular displacement within the beam. The angular displacement is converted into a linear distance by multiplying by the range of the missile from the launching aircraft. This range can be obtained sufficiently accurately by a simple computer device in the missile relating range and time elapsed since launch.

The radar pulses are also modulated to fulfil the second requirement and in this way a measure of the angular displacement relative to the reference axis is obtained.

Guidance information is accepted from the beam by a rearward-looking missile aerial, the characteristics of which are such that

Another aeroplane used for Fireflash trials is the Armstrong Whitworth Meteor NF.11. Note the small radome projecting from the nose of the aircraft.

usable signals are received even while the missile is manœuvring. From the accepted radio frequency signals a crystal detector abstracts the relevant data to be fed to an amplifier. Hence the signals are passed to the two main channels of the guidance receiver, the error wave channel and the reference wave channel.

The signals are demodulated, the polar co-ordinates defining the position of the missile being transformed into Cartesian co-ordinates relative to the control planes of the missile.

The error wave channel is muted until roll stabilization is complete, so that no information is passed to the control circuits until the missile knows which way up it is.

Reference should also be made to the fact that the error wave channel includes a gating circuit by means of which the guidance receiver accepts signals originating only from the aircraft from which it was fired. Interference signals, including those from other aircraft, are rejected.

Also associated with the error wave channel is an automatic gain control device and a stretch control loop. The latter permits the gate to be wide during the searching period immediately after launch, the gate being narrowed down after lock-on. The former controls the gain of the amplifier so that a constant output is received independent of the range and manœuvring of the missile relative to the firing aircraft.

The general function of the control system of the missile is to accept error signals from the guidance system, in the form of two Cartesian co-ordinates defining the position of the missile relative to the beam centre, and, like any other servo-mechanism, to apply control adjustments tending to reduce the two errors to zero, when the missile would be flying along the beam axis.

Three control channels are provided in the control section—the Y and Z control channels deal with the demands from the guidance section, and the roll channel is fed from the roll gyroscope. The outputs from these three channels are routed to a set of four servo amplifiers each of which is connected to and operates an electro-pneumatic relay.

In these relays a spool-valve regulates the pneumatic pressures in two cylinders in which slide pistons mounted on a rocker arm attached to the control surface spindle. The position of the rocker arm, and the corresponding deflection of the control surface depends on the differential pressure between the two cylinders.

The Y and Z channel outputs provide rudder control in the two planes. The roll output is fed simultaneously to all four control surfaces to provide aileron operation. Control mixing is thus done electrically, not mechanically.

Missile manœuvres will, in general, lead to a combination of all three types of control surface movement. Sufficient control power is available to overcome, with an adequate margin, any aerodynamic hinge-moment on the control surface, and to give a very fast response of the surface to demands for control deflection.

Rate gyros and accelerometers are provided in each of the lateral control channels. These supply feedback information on the response of the missile to control surface movements, and control surface feedback potentiometers monitor rudder deflection. The missile is thus stabilized.

Provision is also made:—

(i) To limit the manœuvre demand in each control plane in weathercock motion to a specified lateral acceleration such that, in the small overshoots which occur, the missile is not over-stressed and missile incidences at which undesirable aero-dynamic effects occur are not encountered by the weapon.

(ii) To counteract, as far as is possible, aerodynamic cross-coupling effects between roll and yaw.

(iii) To prevent overshoot and excessive oscillation, by reducing the rate of manœuvre as the missile is gathered towards the beam axis.

(iv) To damp the weaving motion of the missile in the beam.

In all cases the width of the radar beam is adequate to gather any missile fired within the specified operational conditions. The missile when it leaves the launcher tends to head into relative wind.

The aircraft incidence and gravity drop ensures that, in the mean, the missile will lie below the projected longitudinal axis of the firing aircraft when the guidance signals initially influence the control circuits. The extent of this drop relative to the longitudinal axis of the firing aircraft depends on aircraft speed and altitude as well as on other factors. The radar beam is, therefore, directed slightly downwards so that, in average conditions, the missile would be expected to lie on or near the beam axis when guidance cuts in.

There will, however, be factors which cause the missile to be other than near beam axis at this time. These include dispersion due to launch disturbance of the missile or to asymmetrical thrust during boost, aim-wander and recovery from launch disturbance of the firing aircraft, manœuvre of the firing aircraft in tracking a manœuvring target or in attacks from a large angle off.

In all reasonable cases the missile is still well within the beam when guidance cuts in, and there is ample margin to reduce any outward missile velocity radially outwards from the beam axis to zero before leaving the beam. Even gathering from the beam edges in the most adverse cases allows sufficient time for impact.

Thereafter the accuracy of the weapon depends only on:—

(i) The accuracy with which the beam is laid on the target—including effects due to mechanical and electrical misharmonization, tracking inaccuracy and aim-wander.

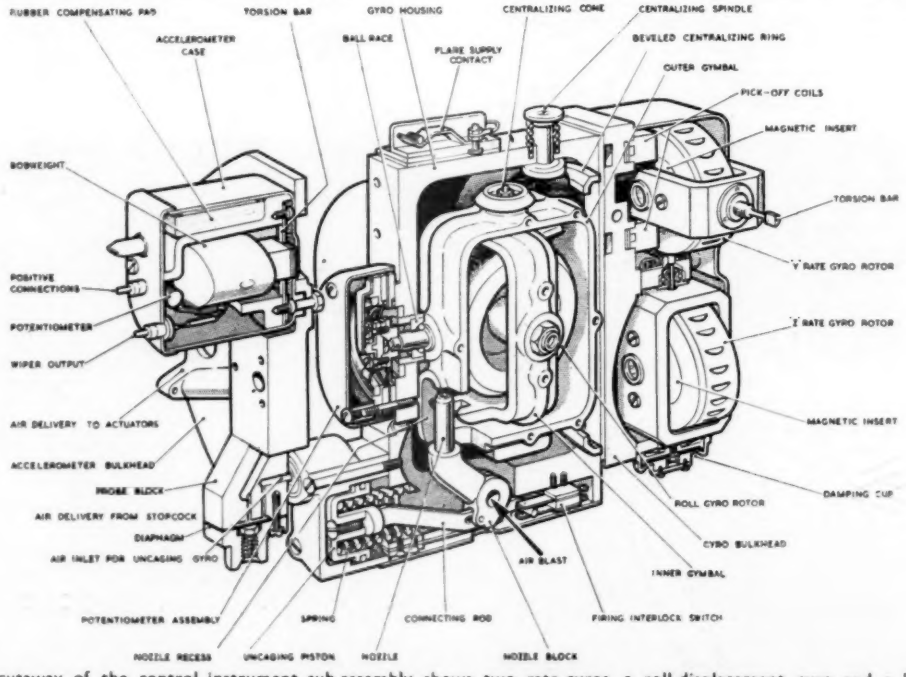
(ii) The accuracy with which the missile would fly along the beam axis, if fixed in space—small inaccuracies due to power supply drifts, etc.

(iii) Effects due to forced oscillation of the missile due to oscillatory motion of the beam in aim-wander.

(iv) Effects due to steady rotation of the beam axis in space due to aircraft manœuvre—this can be eliminated by giving adequate lead by means of a gyro gunsight.

The weapon was not designed to be a hitting weapon. Its fitment with a proximity fuse and a sizeable warhead is evidence of this intention. Nevertheless, a very high proportion of direct hits have been achieved on the small targets used in trials. The root mean square miss distance obtained in all attacks to date is less than the figure called for in the specification, and is sufficiently small to ensure that the majority of rounds fired in anger would actually strike an enemy bomber target. Evasive manœuvre by the target might even increase the chance of direct hit, a hit which would inevitably be lethal. The trials work suggests that, even if aim-wander were to increase to the higher level expected under the strain of wartime operational conditions, adequate accuracy would still be available.

On the basis of their experience, the Fairey Aviation Co., Ltd., believe that a balanced assessment, taking into account the all-important factors—simplicity, reliability and lethality—will prove Fireflash to be as satisfactory an operational air-to-air guided weapon as any available for some years.



This cutaway of the control instrument sub-assembly shows two rate-gyros, a roll-displacement gyro and a lateral accelerometer. One lateral accelerometer has been deleted for clarity.

Private Flying

H.J.C.'s CLUB COMMENTARY

● SUNDAY, August 24, has been selected by the **Luton Flying Club** for its flying display at Luton Airport.

The programme will include aerobatics by sailplanes and by a Hunting Jet Provost, crazy flying, helicopters and a Tiger Club performance. Prizes are to be awarded for time of arrival, a *concours d'élégance* and for the longest distance flown to Luton.

● SO FAR this year the **Hurn Flying Club**, one of the works clubs within the Vickers-Armstrongs Group, has logged 466 hr. Club membership at present stands at 42, of which 31 are licensed, 90% of them on two aircraft types. Eleven members are at present being trained.

Members who have gained their licences this year are Messrs. Corre, Bolton, Hutchings-Lawrie and Goodall. Solos have been flown by Messrs. Beck, Armstrong, Jenkins and Snape.

● RECENTLY awarded by the **A.S. Flying Club** were cups for the best pupil of the year and for the pupil making the most progress. The first went to Mr. J. Hilton, and the second was shared by Miss Margaret White and Miss Diane Hill.

Jim Hilton, by the way, has now joined H.M. Forces, and his place as assistant ground engineer has been taken by Don Craven.

● NEWS from the **Plymouth Aero Club** is that 342 hr. were flown in May and 439 hr. in June. P.P.L.s have been gained by J. C. P. Thomas, J. R. Allen, F. R. Blennerhassett, N. P. Cotter, C. Suter and W. D. Taylor, and by Midshipmen A. C. Macfie, D. N. Phelps and E. M. Wilson.

First solos have been flown by L. J. Bradley, L. Kirby, D. N. Downton and B. A. Clarke, and by Midshipmen D. S. C. Clouston, T. P. Tennant, T. R. Worth, J. J. R. Tod, C. W. Dallmeyer and L. C. H. Townsend. J. Salmond and G. Dobson, training for their C.P.L.s, have made their first night solos.

In the Parachute Group of the club Sub-Lieut. K. R. Alderson, Lieut. M. J. Minter-Kemp and Cdr. M. E. Farey have made their first drops. Peter Lang and Peter Lucas gave demonstrations of both formation and delayed drops at the Plymouth, Exeter and Culdrose air displays.

IN THE SOUTH-WEST.—Members of the Exeter Aero Club and the Bristol and Wessex Aero Club seen at the breakfast patrol at Exeter on July 27. Deteriorating weather allowed many attackers to get in undetected.

● PRODUCED in Los Angeles recently by Aero Publishers, Inc., is "Experimental Light Aircraft and Midget Racers," a 72-page limp-covered book measuring 11 in. by 8½ in. It has been compiled by John Underwood and John Caler,

KEEN TYPE.—Alan L. Marchant, 16, of Greenford, Middx., works at weekends in the office of the Denham Flying Club to help pay for his flying lessons. He is almost ready for solo, but must wait until he is 17 before getting a licence.

and includes descriptions and photographs of more than 300 ultra-light and home-built aircraft. They are mostly of U.S. origin, but other countries are also represented.

There are also brief chapters on amateur aircraft construction in Britain and in France.

The book costs $2.50

● AT THE **Blackpool and Fylde Aero Club**, Squires Gate, P.P.L.s have been gained by W. Towse and J. Adcock; J. Shakespeare, W. Stuart and D. Martindale have flown solo.

An American Sportplane

A NEW prototype lightplane being tested in the U.S.A. is the HPK SP-1, produced by the HPK Aircraft Associates division of the Eagle Flying Service, of Delaware Valley, Penna. The first aircraft is a single-seater, as illustrated, but a two-seat version with nose-wheel landing-gear and tip tanks is proposed.

A 115-h.p. Lycoming O-235-C1 is fitted to the prototype; the production aircraft will have a 150-h.p. Lycoming.

The SP-1 is the first design of the Harold Hayden, Arthur Payne and Robert Kinney team, and was built by Reno Benner. It took five years of part-time work to complete. All new parts were used on the prototype, except for the cowling of a Piper Pacer and a Cessna tailwheel spring. It is an all-metal aircraft; the landing-gear is not retractable; a 6-ft.-diameter fixed-pitch metal propeller is used.

The following data apply to the prototype:—

PERFORMANCE.—Maximum speed, nearly 160 m.p.h.; maximum diving speed 200 m.p.h.; cruising speed, 145 m.p.h.; stalling speed, 50 m.p.h.; take-off run, 400 ft.

DIMENSIONS.—Span, 25 ft.; length, 19 ft. 1 in.; height, 8 ft. 1 in.; root chord, 5 ft.; tip chord, 3 ft.; wing area, 99 sq. ft.; dihedral, 6°.

WEIGHT.—Loaded, 1,300 lb.

Howard Levy photograph

Sailplanes at Leszno, 1958—Part 2

By Peter W. Brooks, B.Sc., A.C.G.I.

(*Continued from page* 210)

HAVING dealt with the new designs in the Open Class in the first part of this article, comment will be made on certain changes, or previously un-noted features, of designs seen at previous Championships as were noticed during casual inspection at Leszno. Most of the designs were described two years ago in the writer's article about the sailplanes at St. Yan. Alternatively, they were covered by B. S. Shenstone's previous commentary on the types at the 1954 Championships at Camphill (THE AEROPLANE, August 20, 1954).

One of the pair of two-seaters in the competition was the German **HKS-1**, stable mate of the HKS-3 single-seater which brilliantly won first place in the Open Class flown by the West German Ernst Haase—the "H" in HKS. The HKS-1 at Leszno was D-5300, the first-built of the two machines of this type, which first appeared in the International Championships in 1954 at Camphill.

The HKS-1, with its Polycell foam and ply sandwich construction and unique wing warping for both lateral control and flap action, was described in THE AEROPLANE of July 23, 1954. In spite of now being five years old, the external condition of D-5300 remains remarkably good and is still, indeed, far superior to that on many more recently built machines.

There were some small indications of surface cracking near the wing-tips, which is presumably associated with the distortion of the skin during the warping action of the wings, but this was not sufficient to suggest that this return to the techniques of the Wright brothers is not entirely practical from the structural-life aspect. The use of warping has certainly achieved its object of effectively preserving the continuity of the upper surface profile.

The only objection would appear to be the ineffectiveness of the lateral control at speeds below the stall, resulting from the limitation on the maximum deflections which can be provided—12 or 13 degrees up and about seven down. These angles are less than half those normally available with ailerons.

The lateral control below the stall is important on gliders because of the need to pick up a wing and maintain lateral balance as soon as possible during take-off. The embarrassment which cross-wind aero-towed take-offs could cause the HKS designs was quite evident on several occasions at Leszno.

The triumphant **HKS-3** is the one and only machine of its type. It first flew in June, 1955, and subsequently came 21st at St. Yan. Except that it is a single-seater, it is closely similar to the HKS-1. The wing does not have sweep-forward (necessary for balance on the two-seater) and its span is 17.2 instead of 19 metres. The wing thickness is increased from 14 to 16 per cent., although a similar NACA 65 series section is used. A most important change, however, is the reduction in wing loading from the very high 35 kg./m.² for the two-seat HKS-1 (29 when flown as a single-seater) to the nowadays quite moderate figure of 25.7.

The two Yugoslav **Meteors** at Leszno, designed by Boris Cijan, were the original machine, YU-4103, and a second which has been built since the first did so well at St. Yan. The two machines are similar except that the second is without the very large wing tip "shapes" which are a feature of the first aircraft. At St. Yan it was not possible to study the rigging and de-rigging of the Meteor so it was particularly interesting to watch this operation at Leszno. Complete assembly takes about 25 minutes, which is one of the penalties of such a complicated design.

The wings are fixed to the fuselage by three gas-pipe attachments on each side, reminiscent of fittings used in some pre-War Junkers aeroplanes. Two of the attachments are to a massive fuselage main frame and the third is at the leading edge. These joints are self-locating and are extremely neat but they are also, one would imagine, very expensive. The controls require three additional connections to be made on each side, spring chucks being used as in the earlier Orao.

The Meteor is notable as one of the few all-metal sailplanes in Europe. Its wing is basically a single-spar structure, although there is a second spar making up a main torsion box for a few feet out from the root.

The spars consist of pressed light alloy webs with lightening holes and root boom plates of steel (about 3 mm. thick and 32 cm. wide at the root), which extend spanwise as far as the second spar. The light alloy wing skin is 1.2 mm. thick at the root, reducing to 0.6 mm. at the tip. The average thickness is 1 mm.

It will be remembered that this remarkably advanced aircraft, with its many sophisticated design features, achieved fourth place in the 1956 Championships in spite of having flown for the first time only shortly before leaving Yugoslavia for France.

Modifications incorporated since 1956 are:—

(1) Tailskid absorption increased by fitting larger and softer spring.

(2) Bobweight in the elevator circuit has been increased (from 0.5 to 1.8 kg.).

(3) Aileron hinges have again been strengthened. They were initially made stronger after the first flights just before St. Yan.

(4) Aileron mass balance has been increased.

(5) Dive brakes have been increased in area.

(6) Certain changes have been made in the instruments and radio.

The Meteors maintained their proud record at Leszno by winning fifth place and (as shown in Table II, see Part I) by together classing themselves as one of the most effective designs. In addition, one of them established a new World's speed record round a 300-km. triangle during the practice period.

The Standard Class Entries

Ten separate designs were entered for the Standard Class competition, which was flown to the same tasks simultaneously with the Open event. The system of marking was the same, being based on the cumulative total of points pro-rated from the 1,000 points awarded each flying day to the winner in each Class. In addition to the flying competition, the 10 Standard Class designs (two in alternative variants) were eligible for the OSTIV prize for the machine which most nearly meets the objectives of the Class. That is to say, this prize was for the most practical 15-metre club sailplane in the judgment of an OSTIV panel of experts, among whom were Boris Cijan, Lorne Welch and Paul Schweizer.

The old designs which appeared at

COCKPIT COMPARISONS.—I. L. to R., top and bottom. The Yugoslav Ilindenka; the Polish Jaskolka of which eleven were entered; the Polish Bocian two-seater; and the French Breguet 905 lightweight.

Leszno and conformed broadly to the Standard Class requirements (with their dates of origin) were:—

(1) The EON Olympia 2 (1939), and
(2) The Slingsby Skylark II (1953)—Britain.
(3) The Schleicher Ka-6 (1955), and
(4) The Schleicher Ka-6B (1956)—Germany.
(5) The SZD Mucha 100 (1954)—Poland.
(6) The Ilindenka (1953)—Yugoslavia.

In addition, there were the following special adaptations of existing designs:—

(7) The EON Olympia 415—Britain.
(8) The Schleicher Ka-6BR, and
(9) The Zugvogel IV—Germany.
(10) The SZD Mucha-Standart—Poland.
(11) The PIK-3C—Finland.
(12) The Rubic Standard-Futar—Hungary.

Finally, the only entirely new design produced for the Standard Class competition:—

(13) The Breguet 905—France.

The **EON Olympia** and **Skylark II** do not call for comment as they are well known. The Olympia has appeared in all previous post-War Championships, while the prototype Skylark I competed at Camphill in 1954. The Olympia 415 can be regarded as a "cut-down" version of the 419, with a wing clipped to 15 metres and a fuselage somewhat shortened. This sort of background results inevitably in a high weight, said to be no less than 100 kg. greater than that of the admittedly probably underweight Breguet 905 prototype!

The **Ka-6** is notable on two counts: it was awarded the OSTIV prize as the design most closely meeting the objectives of the Standard Class, and it came third and fifth in the Standard Class flying championship. This was a notable achievement for this German design by Rudolf Kaiser which was first produced in 1955 as a "Meise replacement."

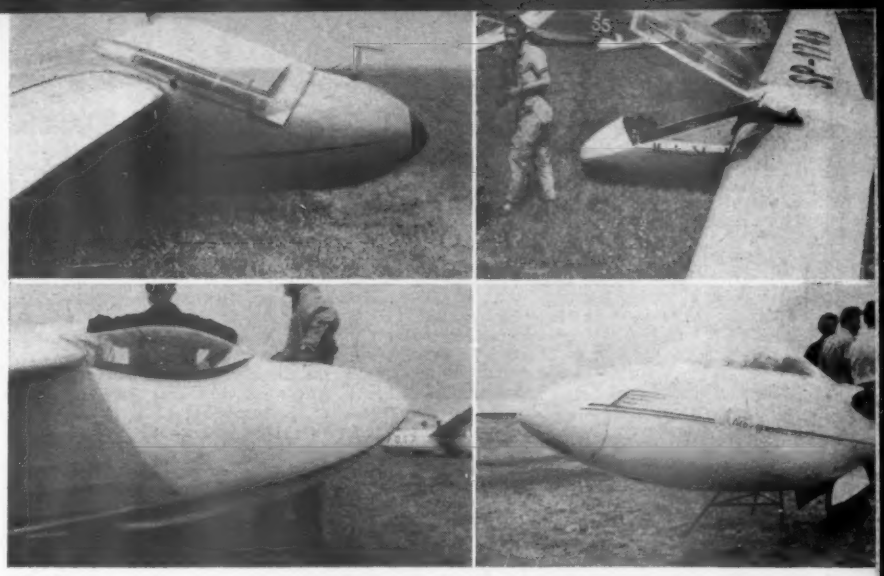
The structure is notably simpler and easier to build than the Meise; in fact, it is believed to require only about 1,400 man-hours to build complete as against, perhaps, 1,800 for the Meise. Some 40 have now been built.

The machine has a tidy, functional appearance which is most appealing. The wing has all its taper on the trailing edge, the taper being sharper on the aileron part of the span. The wing/fuselage junction is particularly neat. The original version was without a fixed wheel, but the Ka-6B has this deficiency remedied to meet the Standard Class requirement. The latest version of the design, which was, in fact, the aircraft which did best in the Championships, is the Ka-6BR, which not only has a wheel but is also provided with an "all-flying" tail which is of noticeably smaller area than the tailplane and elevators on the earlier models.

The new tail surfaces are rigged by threading on to spindles projecting from small stubs at the base of the fin. This arrangement is in contrast to the fixing of the earlier tailplane, which was bolted to the top of the fuselage in a conventional manner.

An interesting point is that the area of aerodynamic horn balance provided on the rudder has been twice reduced in the progression Ka-6/Ka-6B/Ka-6BR. One is left wondering why it has survived at all. Surely there cannot be any problem in achieving a sufficiently light rudder?

Changes in aileron span and in the amount by which the ailerons are inset from the wing-tips also seem to have been made between the different versions.



COCKPIT COMPARISONS.—II. L to R. top and bottom. The Polish Mucha-Standart; another view of this machine; the German Zugvogel; and the Yugoslav Meteor (front skid retracted).

The **Zugvogel IV** is a Zugvogel III with a shortened wing to meet the 15-metre requirement. One of the two machines entered did extremely well in the flying by achieving second place in the Standard Class.

The **Mucha-Standart** is an extensive modification of the widely built Mucha 100, which was itself also used by three pilots at Leszno. The Polish pilot, Adam Witek, achieved his remarkable victory in the Standard Class on one of the two Mucha-Standarts entered. The other came sixth. In addition, Witek came second in terms of points only to Haase in the Open Class, which is a measure of his achievement and a tribute to this new Polish glider.

The Mucha-Standart has a new, entirely ply-covered, wing and a largely redesigned fuselage and tail, so that it has little in common with the earlier Muchas. However, it seems that that old stand-by, the Go 549 wing section—which has been used on so many famous gliders—has been retained. In an environment of laminar-flow sections, flaps and other marks of design progress, the Mucha-Standart certainly stands out! (See Table 1, Part I of this article.) It had the distinction of also being one of the two runners-up for the OSTIV Standard Class design prize.

The other runner-up was the Finnish **PIK-3C**, which is really a PIK-3 as seen at St. Yan, fitted with a new wing. Energetic steps appear to have been taken with this wing to achieve as much laminar flow as possible with a basically non-laminar section. This has extended to using a leading-edge of ply-covered plastic foam and to carrying the ply covering back to the rear spar. The result is an excellent standard of freedom from waviness.

As a further step to maintain a laminar boundary layer over the top surface, an unusual type of lower surface dive brake is used. These brakes arc forward as they open, but look as if they may lack effectiveness.

The Yugoslav **Ilindenka** first flew in 1953 but the type is new to the West. As the wing span is slightly more than 15 metres and there is no fixed undercarriage wheel the Ilindenka does not meet all the Standard Class requirements, and was presumably entered in the Championship only because it is the Yugoslav design which most nearly qualifies. It achieved eighth place in its Class. Typically old-fashioned, undesirable features are the lack of a wheel, a removable—instead of a hinged or sliding—canopy and a large (surely quite unnecessary?) horn balance on the rudder.

The Hungarian **R-22S-D Standard-Futar** is another old design (it first flew in 1944) which has been considerably modified to the requirements of the Standard Class. The wing span has been reduced and the fuselage and tail considerably redesigned. The maximum cross-section of the fuselage is very far aft, giving it a curious "area-ruled" appearance from certain angles.

The rather inadequate retractable undercarriage wheel was kept extended during the Championships, so as to meet the "fixed-wheel" requirement. A neat new cockpit canopy has replaced its ugly counterpart on the original design.

A most unusual feature is the Junkers-type slotted elevator, which is apparently not very satisfactory, because it makes the control too sensitive. It was, however, interesting in view of a lecture to the OSTIV Congress by Alberto Morelli about wind-tunnel tests on a slotted rudder which has been developed to increase the effectiveness of this control on the Italian CVT-2 Veltro.

The most serious criticism of the Standard-Futar concerns the difficulties of rigging and de-rigging—altogether too many loose nuts and bolts—spanners and screwdrivers were in evidence during this operation!

The last design competing at Leszno to be considered here is, perhaps, the most remarkable of them all. If Breguets were disappointed in not achieving a "hat-trick" victory with one of their 901S Open Class machines, they must have felt gratified at the interest aroused in their brand-new **Breguet 905-01** prototype, specially built for the Standard Class Championship. In view of its newness, achievement of ninth place was a creditable effort for this machine, which should have excellent prospects after some further development.

Designed by J. Cayla, the Breguet 905 is outstanding for many novel features.

The wing consists of a D-nose spar built up of a ply and plastic foam ("Klegecel") sandwich to which is attached the ply-covered wooden structure which comprises the rest of the wing.

Each wing is said to weigh only some 35 kg. complete, in spite of its apparent ample strength and quite remarkable local rigidity. This latter characteristic was effectively demonstrated by test pieces on show at Leszno, which enthusiastic potential customers walked on and pummelled to their hearts' content without any visible ill-effects!

The rear fuselage is a boom of similar construction and is of small tapering circular section. The vee-tail is similarly built. The centre section of the fuselage is a very light structure built up of welded steel tubes, and the same technique is used on the prototype for the forward fuselage containing the cockpit. The extreme nose is a plastic fairing. The production aircraft is expected to use a sandwich structure for the forward fuselage.

The concensus of opinion at Leszno seemed to be that the fuselage is at present rather light and will require some "beefing-up." However, the empty weight of the prototype is so low, at 150 kg., that this should be possible without serious consequences.

The cockpit canopy and fuselage lines are very pleasing, and the only possible criticism is that the reduction in fuselage section behind the cockpit may be too sudden. An extension of the fairing farther to the rear might give benefits in reduced drag.

There is also, at present, a rather undesirable discontinuity in the wing profile (its section is in the NACA 63 series) at about 35% chord where the ply covering takes over from the sandwich D-nose spar. These, however, are small points on a design of exceptional promise which gives evidence of originality in its every feature.

Breguets are to be congratulated on a project which, if it realizes its promise for cheap production—they are quoting a price of 1,500,000 frs. (£1,280) complete or 850,000 frs. (£720) as a kit of parts—may well represent a "technological break-through" of far-reaching significance.

The 1958 World Gliding Championships gave just as convincing evidence of the remarkable progress being made in sailplane design and manufacture as they did of spectacular advances in flying technique. Another field of progress, not touched on in this article, is that of instruments and other accessories.

Although it is difficult to determine to what extent, instruments like the British Cook electric variometer and the thermal detector in the HKS-3 are undoubtedly playing an increasing part in competition soaring and may ultimately lead to a complete revolution in technique. Meanwhile, the better-known new accessories, such as the Cook compass, total energy variometers, improved artificial horizons and lighter and more efficient oxygen equipment, have come into widespread use and are already making possible for the majority of competitors a standard of performance which was achieved by but very few pilots until quite recently.

Dr. A. E. Slater Reports on

NATIONAL GLIDING WEEK

THERE WERE 41 entries for this year's decentralized National Gliding Week, compared with 70 at last year's centralized National Gliding Championships. It was a promising start to a new idea in national gliding contests, designed to fill the gap in a year when the British Gliding Association could not organize a full-blown contest on its own because it was too busy sending a team abroad.

The six gliding clubs which offered to co-operate could have dealt with 84 sailplanes between them, but three did not receive enough entries to make it worth while holding a contest. Of the remaining three, the Bristol Club proved the most popular with its full quota of 20 machines, flown by 38 different pilots; the London Club at Dunstable had 14, with 19 pilots; and the Scottish Gliding Union had seven with 12 pilots.

The nine-day period from July 27 to August 4 got off to a poor start, with a contest only in Scotland on the first day and only at Dunstable on the second; but on July 28, 30 and August 2 the weather allowed contests at all three places, after which a low stratus layer clamped down on the whole of Great Britain for the last day and no tasks were set, anywhere. Dunstable usually got Nympsfield's depressions about six hours later, but Portmoak maintained its own independent Scottish weather.

* * *

Let us start with Dunstable, where the chairman of Luton R.D.C., Mr. B. J. Hyde, performed the official opening. Here the R.A.F. had turned up in strength with five entries, and set up their own camp, complete with field kitchen, under the command of Wg. Cdr. N. W. "Paddy" Kearon. They brought two Skylark 3s, an Eagle, and laminar-flow Olympias 419 and 415. Other visitors from outside the club were Dr. D. B. James from Surrey (Skylark 2), A. H. Warminger from Norfolk (Skylark 3) and Chris Wills and Toby Fisher from Bristol (Kit 2). Two Tiger Moths, the club's and John Furlong's, were available for launching.

* * *

An abortive task of distance along a line through Downham Market was set on the first day, with a warm front approaching from Nympsfield; only Kearon went off in chase of the retreating fine weather on the eastern horizon, but failed to catch it. Next day, Monday, the wind was too rough for tugs, though not, of course, for sailplanes, which were winched into the hill lift. Kearon won the day with a flight to Ely, 52 miles. The Polar Front was still unpleasantly near to the south, producing a lot of low cloud, with rain in addition at Nympsfield.

C. E. Wallington, by the way, was forecasting for both places.

Now came two comparatively good days, with flights to the east coast. On July 29 the task was "distance along a line through Beccles," which, being produced, reached the sea just north of Lowestoft, 108 miles from Dunstable. James landed his Skylark 2 on the foreshore, then Sgt. Andy Gough put down the Olympia 419 a little nearer the line in a vacant space between spread-out fishing nets; Flt. Lt. Roger Mann, with the Olympia 415, found a playing field still nearer the line, and Charles Ellis landed farther off it. No one else got beyond 85 miles, as the cumulus petered out at Thetford, and anyone going farther had to wait for the chance of a cu-nim.

The first three, whose "projected" distances along the line were found to be the same, each earned 100 points.

* * *

Next day the task was "pilot-selected goal" and many people chose Great Yarmouth, 100 miles away. Warminger, Mann, Ellis, Flg. Off. F. D. Cretney and Kearon (last to take off) all got there, and R. D. Ruffett missed it by eight miles in an Olympia. But Gough reached Winterton, a little farther up the coast, giving him three extra miles so that he became the day's winner. James had ambitions for Scarborough and reached Spalding.

Thursday, July 31, was the first race day, with a course to Glatton, south of Peterborough, and back, 86 miles in all, first N.N.E. then S.S.W. across a light W.S.W. wind. The course was only completed by James, Gough and Mann, the last taking 6 hr. 25 min., including 2 hr. trying to get away from the neighbourhood of Alconbury on the way back. James won the Daily Prize, a year's subscription to the THE AEROPLANE.

After a day's rest, an unusual type of race was given on August 2, along a dog-leg course—62 miles N.E. to Feltwell and then 44 miles S.E. to Martlesham Heath, with a 30-knot wind blowing at 45° to either course. The cumulus clouds were tall and, as often in such clouds, by the time they had grown big, all the hot air had gone up into them and there was none left below.

Mrs. Robert Kronfeld presented the prizes: Gough (426 points) won a model of the Olympia 419; Ellis (379) a Ronson table lighter; Kearon (342) a consignment of Guinness; Cretney (329) a pewter tankard. For the Daily Prizes, sailplanes were divided into three classes according to performance, one class being eligible each day.

BRISTOL GLIDING CLUB at Nympsfield had two days' clamp, then two days' mediocre weather, followed by three good long-distance days, and finally another two days' clamp. They had two tugs from the Tiger Club and one from the Oxford Gliding Club to do most of the launching.

The first task on July 29 was "distance along a line through Coltishall," 170 miles away in Norfolk, but no one could get half as far, and Peter Neilson, with the Cambridge Club's Skylark 2, who made the best distance of 64 miles to Towcester, was below 1,800 ft. (above take-off) for the first half of it. Next best in order were John Neilan and Malcolm Laurie in their Eagle, Peter Scott and Peter Collier in theirs, Flt. Lt. A. T. Morgan in an R.A.F. Olympia from the Windrushers' Club, another Eagle from the Army Club, and John Williamson in Nick Goodhart's Skylark 3; no one else got away.

Leading totals for the meeting were: Nicholas Goodhart and Williamson with Skylark 3 (310 points); Burton with Olympia, sharing second place with the Eagle flown by John Neilan; Malcolm Laurie, Lorne and Ann Welch (192) each; Scott and Collier with Eagle (191); L. Redshaw, who normally flies his Olympia around the Lake District and is rarely seen by anyone else (169).

* * *

PORTMOAK, the Scottish Gliding Union's site near Kinross, had some interesting visitors from the south. Philip Wills and Geoffrey Stephenson each brought a Skylark 3, but both flew *hors concours*; W. N. "Bill" Tonkyn and B. J. Davey brought a private one from the Imperial College Club at Lasham, and from the Midland Club at Long Mynd came Col. Geoff Benson and Ted Stark and Charles Green with their Skylark 2. The home club supplied three entries: Andrew Thorburn with one club Olympia, Charles Ross and D. P. Docherty with the other, and W. "Bill" Lawson with his own Eagle.

Wills with 366 points, and Stephenson with 364, made the highest totals for the meeting, though unofficially. First prize went to Tonkyn and Davey with 353, Thorburn totalled 122, Lawson 64, and Ross with Docherty, 30 points.

(*More details of these last two meetings will appear next week.*)

Correspondence

Public Opinion the Arbiter

From Sir Frederick Tymms, K.C.I.E., M.C., F.R.Ae.S.

YOU have rightly said that the Guild of Air Pilots and Air Navigators feels intensely that the proposed memorial to the R.34 is an outrage to the memories of the men who flew twice across the Atlantic in this airship in 1919, and those who built her.

We have heard the argument that art should be left to artists, who alone can evaluate it. This is not the criterion by which to judge a memorial to great aeronautical achievement—the point is that the deed should be fittingly and worthily commemorated.

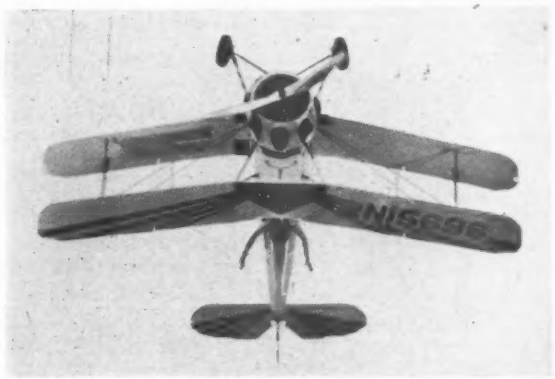
We in the Guild know the spirit of the men concerned, and we believe we have an equal appreciation, with others, of the significance of the event, we hope it will not be necessary to raise funds to prevent the erection of the memorial, as Mr. Bridgman suggests, but that public opinion will stop the perpetration of this outrage.

London, W.1. F. TYMMS.
(Master, the Guild of Air Pilots and Air Navigators.)

"Bevo" Howard's Aerobatics

THANK you for showing a picture of the Bücker Jungmeister on page 369 of the March 14 issue of THE AEROPLANE. I believe this photo was taken at the Miami International Air Show and Exposition held January 24, 25, 26, 1958.

For your information, the original engine was the German



This picture, sent to us by "Bevo" Howard, shows him flying hands-off, inverted and 150 ft. up, at the 1958 Miami Air Show.

Siemens Sh-14A and this engine was replaced in 1949 with an American 185-h.p. Warner Super Scarab instead of the 220 Continental as mentioned in your publication.

Enclosed is a photo of the Bücker in action that you might like to see.

Moultrie, Georgia. BEVERLY HOWARD.
President, Hawthorne School of Aeronautics.

Unfilmed Epic

LIKE several products of the British aircraft industry in post-war years the "Long Hop," as the film of Alcock's and Brown's transatlantic flight was to have been titled, was the victim of a sudden withdrawal of financial support at a critical moment in its production: i.e., 10 days before "going on the floor" at the studios.

This was not in any way due, as your correspondent (THE AEROPLANE, July 25) suggests, to the "anti-climax" of the Vimy's landing, but to a drastic change in the Treasury's financial aid to the film production company concerned. The landing was surely a very dramatic and human ending to a heroic flight undertaken against great odds. The fact that the Vimy nosed into a bog was irrelevant; both Alcock and Brown were too tired, too happy, to care—they had, after all, achieved what they set out to do.

Production plans for the film were far advanced when the blow fell. The script was written, the leading rôles cast and the sets built; a taxi-worthy replica of the Vimy had been constructed, also a radio-controlled flying model, and some preliminary filming of backgrounds done in Newfoundland—but film finance is as fickle as that of some of the aircraft industry's more enterprising projects.

The rest is now history. Eighteen months later Hollywood produced "The Spirit of St. Louis" and a generation of young filmgoers doubtless believe that Lindbergh's was the first transatlantic flight.

London, W.4. GRAHAM WALLACE.

Groundabout

Sarcophoguy. U.S.A.F. Air Research and Development Command say that a man partially submerged in water can withstand 13 *g* for 4 min. Tests were made with pilots in a coffin-like container. In these high *g* conditions he could still move his limbs, so it seems to have been a good opportunity to try out those pens which write under water, if they also had some waterproof paper.

*

Liquid. "Hydraulics is the science of variable constants."—*Theodore von Kármán.*

*

Vintage C.G. At the latest of Qantas' well-established and matey Press conferences, Bill Crowther, Western Division manager, recalled to me his first visit here, back in 1936, when he and two other Qantas pilots, Lester Brain, now D.H. Australia's managing director, and Bob Gurney, came on a flying-boat course. They called, of course, on Charles Grey, this magazine's founder-editor, who framed a definition which Bill remembers word for word, to this day: "The Australian is not a bad sort of fellow if you let him think that you don't mind if he tells you to go to hell."

*

Hatchet Buried. American publicity experts are properly called "hatchet men." One of them, a jet-liner publicist, flew in a U.S.A.F. C-130 turboprop transport and was afterwards heard to comment, "Well, Lockheed have solved the turboprop noise problem—they've funnelled it all into the fuselage."

*

Dropping Zone. Aircraft construction, which we know is expensive, can also be hazardous. In the costing figures for the Comet 4 there is probably one item which goes: "To purchasing large quantities of thin plastic sheeting and attaching to factory roof girders beneath birds' roosting perches . . . ."

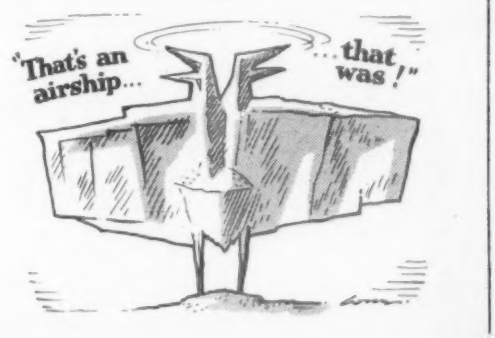
*

Radar Superseded. To help solve the worsening Air Traffic Control problem, I reckon there should be a newspaperman in every control tower. They get to know so much so quickly. For instance, the first intimation that London Airport and B.O.A.C. had that Mr. Macmillan's aircraft was turning back from his recent Atlantic flight came from newspapers ringing up for information about it.

*

Air Charter are claiming to have the largest civil air fleet in the U.K. As well as their usual operational aircraft they now have 283 Prentices on their books.

*



by Gresham

NOTES AND EVENTS

ELECTRONIC ENLARGER.—E.M.I. Electronics, Ltd., has developed this electronic enlarger for aerial survey and other fields. It can print from 35 mm. to half-plate negatives, and uses a light integrating system which terminates the exposure automatically to produce a uniform print density without adjustment for widely varying negative densities.

FLIGHT INSTRUMENTATION.—A new design of Vertical Reference Gyro, which provides a source of pitch-and-roll signals for the operation of remote indicating flight instruments such as attitude indicators, flight directors and other equipment requiring such signals, has been developed by Ferranti, Ltd. A feature of the new gyro, known as the F.S.16, is that all components are contained in a 4½-in. diameter by 9-in. case. It has a gimbal freedom of 360° in roll and ± 85° in pitch.

SHORT COMPUTER.—Following its recent exhibition at the Poznan Trade Fair, a Short Brothers and Harland, Ltd., analogue computer is now in use in the Institute of Automation of the Polish Academy of Sciences, Warsaw.

BP PUBLICITY.—Two new publications, both of a high standard, have just been issued by the BP Aviation Service. First is the annual edition of the "Spotters Log," which is a "give-away" available on application. This 40-page publication, measuring 4 in. by 7¼ in., contains many silhouettes of well-known aircraft, technical information, blank log pages, and international civil markings. The "Book of Airlines" is a specially good production containing no fewer than 81 side-view drawings, obviously the work of John Stroud, showing, in colour, the markings of that number of airlines which are IATA members. Details of fleets and operational data are also given. At 3s. 6d. this book can be obtained from Britannic House, Finsbury Circus, London, E.C.2.

NEW ALLOYS.—J. Stone and Co. (Charlton), Ltd., has introduced some new magnesium-based alloys containing silver, rare earth metals and zirconium. Showing a good resistance to creep at temperatures of the order of 200° C. and to proof stresses up to 13½ tons/sq. in., the new alloys are stated to be suitable for engine castings and missile components. Fully weldable, they are not liable to stress-corrosion failure.

The Report that Never Was

IN its lifetime the aircraft industry has been subjected to many committees and councils and perhaps the most famous of these was the Brabazon Committee. The result is that librarians, publishers of aeronautical periodicals and the rest are frequently, at odd periods, asked for The Brabazon Committee Report. The inquirer is invariably sure that there must be one because he has seen references to it. He refuses to be told that there is no such thing.

Let us, therefore, lay this ghost once and for all time by reference to Hansard of July 9, 1947, Column 2185, where the Parliamentary Secretary to the Ministry of Civil Aviation says:—

"It is not proposed to publish the reports of the Brabazon Committee, the outcome of whose recommendations has been made known from time to time in Parliament. . . . The reports are confidential and publication of some of the information would not be to the national advantage."

—F.H.S.

RADAR AND ELECTRONICS.—The next series of lectures to be held by the Radar and Electronics Association will be at the Royal Society of Arts, John Adam Street, London, W.C.2. The first lecture will be given on September 23.

Aviation Calendar

August 16-17.—Second Wines-of-Alsace rally organized by the Aéro-Club Centre, **Alsace,** France.

August 18.—International Military Aeronautical Pentathlon. at **Ostend,** Belgium.

August 24.—Luton Flying Club Air Display at **Luton Airport.**

August 31.—Oxford Aeroplane Club "At Home," at **Kidlington Airport,** Oxford.

September 1.—S.L.A.E. main lecture, "The Engineering Development of Turbine Aircraft as Influenced by World Traffic Patterns," by D. J. Lambert, A.M.I.Mech.E., A.F.R.Ae.S., assistant general manager, development, Vickers-Armstrongs (Aircraft), Ltd., in the main assembly hall, R.A.E., **Farnborough,** Hants, at 18.30 hrs.

September 1-7.—S.B.A.C. Display and Exhibition, at **Farnborough.**

September 4-6.—AGARD Avionics Panel Meeting at **Cambridge University.**

September 8-13. — First International Congress of the Aeronautical Sciences, **Madrid.**

September 12-22. — Aeronautical Pentathlon and Air Rally at **Liège,** Belgium.

September 15-21. — Battle of Britain Week.

September 20.—Aviation Forum of London, annual dinner, at the Aerodrome Hotel, **Croydon,** Surrey.

September 21.—Sailplane aerobatic competition organized by the London Gliding Club, at **Dunstable,** Beds.

September 21.—Air Rally organized by the Milan Aero Club, at **Milan.**

September 21.—Royal Belgian Aero Club international concourse for balloons, **Brussels.**

September 26-29.—Austrian Aero Club Rally at **Innsbruck.**

GENEVA EXHIBITION.—More than 25 member firms of the Scientific Instrument Manufacturers Association of Great Britain are to show their latest developments at the Second International Exhibition of the peaceful uses of atomic energy—"Atoms for Peace"—at Geneva from September 1 to 14. A total of 250 participants from 13 countries are taking part in the exhibition.

Company Notices

NEW COMPANIES

Aero-Transport Facilities, Ltd. (608,351).—Private co. Reg. July 21. Cap. £100 in £1 shs. Objects: To offer aircraft for hire or charter, etc. Permanent directors: Peter J. Souster, Avon Castle, Ringwood, Hants, Kenneth H. Blackham, 1 Livingston Rd., Derby. Sec.: Brian D. Hetreed. Reg. off.: 33 Bedford Row, London, W.C.1.

J. and M. Aircraft Spares, Ltd. (608,660).—Private co. Reg. July 25. Cap. £100 in £1 shs. Objects: To carry on the business of dealers in Government surplus stores, etc. Directors: Harry J. Jackson, St. Leonards, Hill Top, Hale, Cheshire; Ernest A. Moritz, 26 St. Mary's Rd., Prestwich, Lancs. Sec.: E. A. Moritz. Reg. off.: 9 Lower Mosley St., Manchester.

INCREASE OF CAPITAL

Glamorgan Aviation, Ltd. (573,963).—Quay St. Chambers, Quay St., Cardiff. Increased by £2,000 in 10s. ordinary shs., beyond the reg. cap. of £2,000.

New Patents

APPLICATIONS ACCEPTED

801,550.—Sperry Rand Corporation.—"Gyroscopic vertical-reference-defining apparatus."—Mar. 13, 1956 (Mar. 21, 1955).

Application open to public inspection on Sept. 17, 1958; opposition period expires on Dec. 17, 1958.

801,941.—Bendix Aviation Corporation.—"Control systems, for steering a craft."—Feb. 28, 1956 (Mar. 4, 1955).

801,832.—Fiat Soc. Per Azioni.—"Fuselage structure for jet-propelled aircraft."—Sept. 18, 1956 (Sept. 24, 1955).

801,977.—Soc. des Forges et Ateliers du Creusot Soc. Anon. — "Movable panels."—Jan. 31, 1957 (Feb. 17, 1956).

801,995.—Svenska Aeroplan Aktiebolaget. — "Arrangement in actuating mechanisms on aircraft ejection seats."—Oct. 15, 1956 (Oct. 19, 1955).

802,021.—Soc. d'Inventions Aéronautiques et Mechaniques S.I.A.M.—"Landing gear for aircraft."—Dec. 13, 1955 (Jan. 13, 1955).

801,879.—General Motors Corporation.—"Aircraft propeller drive unit."—Feb. 14, 1957.

Applications open to public inspection on Sept. 24, 1958; opposition period expires on Dec. 24, 1958.

Personal Notices

BIRTHS

Akhurst.—On July 29, at Elgin, to Lois (*née* Arnold), wife of Flt. Lt. Dennis Akhurst—a son.

Bowen-Easley.—On August 1, at Lytham Hospital, Lancs, to Ruth (*née* Hughes), wife of Sqn. Ldr. F. Bowen-Easley—a daughter.

Browne.—On July 31, at Wimbledon, to Marian (Mary), wife of Sqn. Ldr. D. F. M. Browne—a son.

Comer.—On July 19, at Cottesmore, to June, wife of Flt. Lt. B. A. Comer, D.F.C., A.F.C.—a daughter.

Freeborn.—On July 26, at South Cerney, to Jennie (*née* Collinson), wife of Flt. Lt. A. J. Freeborn—a son.

Gratton.—On July 22, at Norfolk and Norwich Hospital, to Sheila (*née* Lamplugh), wife of Flt. Lt. J. B. Gratton—a son.

Horton.—On July 31, at Halton Hospital, to Beris May, wife of Wg. Cdr. T. W. Horton—a son.

Martin.—On July 30, at Tidworth Military Hospital, to Eileen (*née* Currah), wife of Sqn. Ldr. K. Martin—a daughter.

Smith.—On July 25, at Zachary Merton, Rustington, to Brenda (*née* Harris), wife of Flt. Lt. P. E. Smith—a daughter.

South.—On July 22, at Louise Margaret Hospital, Aldershot, to Sheila, wife of Sqn. Ldr. G. J. South—a son.

Thompson.—On August 1, to Betty (*née* Mackfall), wife of Flt. Lt. M. O. Thompson—a son.

Woods.—On July 28, at Oxford, to Margaret (*née* Mangham), wife of Flt. Lt. A. G. Woods—a daughter.

Yearwood.—On August 3, to Jean (*née* Barnwell), wife of Sqn. Ldr. H. G. Yearwood—a son.

Young.—On July 28, at R.A.F. Hospital, Nocton Hall, to Isabel, wife of Flt. Lt. M. Young—a daughter.

MARRIAGES

Goadby—Cooper.—On July 19, at St. Mary's Church, Sidlesham, Sussex, Flt. Lt. Goadby to E. M. Cooper.

Townshend—Mappin.—On July 26, at Yateley Parish Church, nr. Camberley, Flt. Lt. P. Townshend to B. Mappin